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Bulletin of the Museum of Comparative Zoölogy
AT HARVARD COLLEGE
VOL. LXXXIV

REPORTS ON THE SCIENTIFIC RESULTS OF THE EXPEDITION TO THE EASTERN TROPICAL PACIFIC, IN CHARGE OF ALEXANDER AGASSIZ, BY THE U. S. FISH COMMISSION STEAMER "ALBATROSS," FROM OCTOBER, 1904, TO MARCH, 1905, LIEUT.-COMMANDER L. M. GARRETT, U. S. N. COMMANDING. XXXVII.

THE CILIATA: THE TINTINNOINEA

BY

CHARLES ATWOOD KOFOID AND ARTHUR SHACKLETON CAMPBELL

WITH THIRTY-SIX PLATES

CAMBRIDGE, MASS., U. S. A.
PRINTED FOR THE MUSEUM
APRIL, 1939

PUBLICATIONS

OF THE

MUSEUM OF COMPARATIVE ZOÖLOGY

AT HARVARD COLLEGE

There have been published of the BULLETIN, Vols. I to LXXXV, No. 1 & 2; of the Memoirs, Vol. I to LIV, No. 1, 2 & 3, and Vol. LV.

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THE TINTINNOINEA OF THE EASTERN TROPICAL PACIFIC

WRITTEN BY

CHARLES A. KOFOID AND A. S. CAMPBELL

Conducted in Part Under the Auspices of the

WORKS PROGRESS ADMINISTRATION

Official Project Number 165-03-6999

Serial Number 0803-847

Works Progress Number 6079-5797

DISTRICT 8, BERKELEY, CALIFORNIA

PR-K

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The Ciliata: The Tintinnoinea[1]

BY

CHARLES ATWOOD KOFOID AND ARTHUR SHACKLETON CAMPBELL

INTRODUCTION

This Report deals with the Tintinnoinea, a suborder of the pelagic heterotrichous Ciliata, taken by the U. S. Fish Commission Steamer "Albatross" in the silk-net collections of the microplankton during an expedition to the Eastern Tropical Pacific, from October, 1904, to March, 1905, under the leadership of the late Alexander Agassiz. An account of the Expedition will be found in Volume 33 of the Memoirs of the Museum of Comparative Zoology at Harvard College (Agassiz, 1905), and a map of its route with station numbers on plate 36.

ACKNOWLEDGMENTS

For grants in aid of the work we are indebted to Alexander Agassiz, who, at the close of the Cruise, continued his already manifest interest in the work for several years. Without the substantial grants made by the Board of Research of the University of California from 1917 to 1936 we could not have brought to a finished, coordinated whole, the voluminous mass of detail in the records, drawings, and notes, and the often perplexing revision of the group whose previous status was one of systematic chaos.

The original sketches and records of occurrence based upon the painstaking and repeated examinations of the microplankton were made with the assistance of Mrs. Elizabeth Heald Purington, M.A.,

[1] Printed with the aid of a special gift from Mr. George R. Agassiz.

University of California, 1911, Agassiz Research Assistant in Zoology to the senior author from July, 1910 to June, 1914, and Research Assistant to him from July, 1914 to June, 1917. Her sketches have been utilized in the text figures, and her detailed, finished Ross board drawings enhance the plates. Her skill in the portrayal of contour and minute detail by this method contributed profoundly to the beauty and accuracy of the plates. Miss Dorothy Harris made some of the drawings for the plates and text figures, and Mrs. Frieda Abernathy made some of the Ross board drawings and assisted in the reorganization of the plates.

During the Cruise the senior author made daily observations and notes on the plankton collected, and throughout the course of the work has continued in closest collaboration in the microscopical, morphological, and systematic analysis of the material. He has resolved the structures of the individuals utilized in the elaborate finished drawings, which he supervised to their completion.

The junior author has utilized his research time and his vacations from his obligations as Professor of Zoology in St. Mary's College, California, for the revision of the senior author's first draft of the manuscript of all families except the Undellidæ and the Tintinnidæ, and for the preparation of the first draft of the manuscript of those families.

Both authors have collaborated in the revisions which have arisen from new viewpoints of systematic relationships, the recognition of structures of greatest systematic value, the detection of areas of greatest environmental modification, and clearer concepts of generic and specific characters and limits. The senior author has revised and condensed the second draft to its present form.

Grateful acknowledgment is made to Mrs. Laura G. Rauch for final reading of the manuscript.

This report is a condensation of a much more extensive manuscript now filed in the General Library of the University of California. In the process of condensation all synonymy except that resulting from publications since the appearance of our Conspectus (1930), comparisons of species, discussion of figures and accounts of the species previously published, discussion of occurrences previously reported, 1069 text figures and all maps of distribution of species have been eliminated. The plates were also materially reduced both in number and magnification.

DISTRIBUTION OF RECORD STATIONS

Collections and methods of examination were described in Kofoid and Skogsberg (1928). Collections were utilized from 130 stations on the Cruise. A list will be found in Part IV, together with the pertinent data. A fuller account of the stations appeared in the *General Report of the Cruise* by Mr. Agassiz (1906). The distribution of the stations on the six lines of the Expedition is shown in Plate 36.

There were 174 collections at numbered stations. Of these 79 are from the surface, 1 from 100–0 fathoms, 1 from 150–0 fathoms, 1 from 200–0 fathoms, 64 from 300–0 fathoms, 2 from 400–0 fathoms, 1 from 550–400 fathoms, 22 from 800–0 fathoms, 1 from 2031–0 fathoms, 1 from 2125–0 fathoms, and 1 from 2228–0 fathoms. In addition to these hauls from surface and deeper levels, there were incidental plankton collections at anchorages at Panama, off Easter Island, in the lagoon at Manga Reva, and in the harbor at Acapulco, Mexico; minor records from the California coast are utilized only incidentally. Records from the gut of salpæ are not included in frequency percentages, since they are few, the level of occurrence of the tintinnids found uncertain, and the specific identity of the salpæ not determined. The distribution of the pelagic stations in the several oceanic currents is shown in detail in the following table:

DISTRIBUTION OF PELAGIC STATIONS IN OCEANIC CURRENTS

Current	*Total of Stations*	*Surface and Intermediate*	*Surface only*	*Total of Intermediate*	*Total Number of Surface*
California Current	5	4	1	0	5
Mexican Current	13	0	8	5	8
Panamic Area	18	2	11	5	13
Peruvian Current	26	15	2	9	17
Easter Island Eddy	11	0	6	5	6
Galapagos Eddy	4	0	2	2	2
South Equatorial Drift	46	0	22	24	22
South Equatorial Current	3	0	2	1	2
Equatorial Counter Current	2	0	2	0	2
North Equatorial Current	2	0	2	0	2
	130	21	58	51	79

Confirmatory data derived from material collected during the senior author's traverse of the Pacific from Seattle, Washington, to Colombo, Ceylon, and during a traverse from San Francisco to Japan in 1929–30, and from material received from the Scripps Institution and its predecessor at San Diego, California, as well as from the "Albatross" in Alaskan and other waters, aided us substantially in strengthening many of the conclusions reached in this report. Additional data have been secured from the cruise of the "Zaca" in the same waters during the spring of 1932, through the courtesy of Mr. Templeton Crocker and from minor collections from various sources.

ORGANOLOGY AND BIOLOGY OF THE TINTINNOINEA

In fresh waters, such as temporary infusions, pools, and small bodies of water subject to extreme changes of environmental condition, the different orders of Ciliata, the Heterotrichida, Oligotrichida, Hypotrichida, and Peritrichida, are all abundantly represented, especially in enriched waters. The littoral fauna of larger bodies of fresh water, such as large rivers and permanent lakes, exhibits a comparable diversity of ciliate population, but rarely attains the large numbers, either of species or of individuals, of the smaller bodies. The area of neritic influences in salt water, including salt marshes and the littoral zone of all seas, likewise has a diversified ciliate fauna.

With the increase of size of the body of water, the limnetic and pelagic ecological regions emerge and the direct environmental effects of the substrate progressively decrease and all but vanish. The ciliate fauna responds by an abrupt change, even more abrupt, in fact, than that of the retreat of the substrate, because of the relatively small sizes of the ciliates as compared with those of the larger elements of the fauna.

The change in the ciliate fauna is accomplished by the reduction in, or the almost complete disappearance of all orders of ciliates except the Heterotrichida, and the predominance of one of its suborders, the Tintinnoinea. In large bodies of fresh water the plankton contains only the abundant and widely distributed *Codonella cratera* and a few rarer species of Tintinnidium and Tintinnopsis. In the sea, on the other hand, the suborder Tintinnoinea has been developed to an extraordinary degree as an important quantitative constituent of the microplankton. The Tintinnoinea have definite ecological relations with both the protophyte flora of the illuminated subsurface zone and

with the bacteria of the littoral region and the zone of decay of the phytoplankton near the light floor of the oceanic areas. The suborder has also undergone an evolutionary development with accompanying structural diversification until over seven hundred and fifty valid species in thirteen families and sixty-two genera have been evolved.

The ecologic niches occupied in the sea by the Tintinnoinea are more restricted ones than those filled by ciliates dependent upon the substrate. The ciliates of the non-pelagic habitat are diversely adapted in feeding habits and utilize varied sources of food supply. Some are gross omnivorous feeders, some highly selective, some herbivores, and others carnivores.

The Tintinnoinea of the pelagic fauna of the sea are primarily feeders upon nannoplankton, mainly bacteria, minute algæ, and small flagellates, especially Coccolithophoridæ, and the smaller ciliates and dinoflagellates. There is considerable evidence among them of selective feeding which is reflected in the consistency and alveolar patterning of the secreted matrix of the lorica, and especially in the utilization of coccoliths in the lorica. Species of certain families such as the Undellidæ and Tintinnidæ which rarely, if ever, build coccoliths into the walls of their loricæ, occur together with those of other families, such as the Codonellidæ and Dictyocystidæ, whose loricæ habitually contain coccoliths. Furthermore, certain species seem to utilize particular coccoliths and not to use others.

Morphology of the Body

The body is trumpet-shaped with an aboral adhesive tip attached distally either at or near the center of the bottom of the lorica or on its side below the middle on its inner face. The aboral region may be drawn out in a long slender contractile stalk. A radially spreading adhesive area of attachment terminates the body. The point of attachment is fairly constant within the species and characteristic of the genus. The pyriform column increases distally in diameter above the stalk, its most anterior region flaring above the column abruptly in a wide, truncated segment of an inverted cone, the peristome collar, with a length considerably less than that of the stalk. Around the margin, there is, in some species, a rounded, thickened, flaring, nonrecurved rim. Below this, on the ventro-sinistral surface of the column, there is usually a broad, rounded, triangular, blade-shaped, vertical lateral lobe. The rim of the peristome is not a complete circle, but is a flattened, left-wound, single-whorled spiral, enclosing the adoral mem-

branelle zone. In Cyttarocylis, Cymatocylis, Favella, Eutintinnus, Helicostomella, Amphorella, some species of Tintinnopsis, and *Xystonella lohmanni*, there is no thickened peristome rim; the column and peristome uniting evenly with a thin lobate or undulating margin with a single crescentic lobule between adjacent membranelle.

The nuclear system is made up of one or more macronuclei and the same number of micronuclei. Records of larger numbers are noted in the literature of the various species (up to 300 in the case of *Petalotricha ampulla*), but in these instances the authors have not considered the mitotic state of the animal, endomixis, or the nuclear multiplication which intervenes between the zygote and the first binary fission.

An account of the neuromotor apparatus or fibrillar system will be found in papers by Campbell (1926a, 1927, 1929, and 1930) in *Luminella pacifica*, *Stenosemella nivalis*, and *Favella franciscana;* by Entz, Jr. (1927) in *Favella ehrenbergii* and (1929) in *Petalotricha ampulla;* and by Hofker (1931b, figs. 22, 23a, b,) in *Tintinnopsis campanula*.

A very powerful organelle, the ciliary membrane, is found in *Tintinnidium fluviatile*, *Tdm. neapolitanum*, all species of Tintinnopsis, *Codonella galea*, Codonellopsis, and Stenosemella. This organelle has been observed by Hofker (1931b, figs. 25, 27) to carry secreted material outside and deposit it on the outer surface of the lorica. However, its absence in many genera shows that it cannot be the primary organ of lorica-formation. The membranelles alone of all the organelles of the animal are in a satisfactory position to achieve this office. The ciliary membrane, however, is probably accessory to lorica-formation in that it does assist in the adding to the upper end of the lorica after its formation. This membrane arises from, or below, the peristome rim and continues in an oblique line down the upper fourth or more of the ventral body wall to the left of the lateral ciliary field. It is a system of elongated, highly mobile, flat, brush-like cilia which arise from a single row of large, globular basal bodies.

The adoral membranelles number from twelve in Tintinnidium and Codonaria to as many as twenty-four in some other genera, such as Rhabdonella. Their number seems to be constant in each species. The membranelles are relatively large, long and wide, forming squarish petal-like blades about 2.5–3.0 times as long as broad. They are inserted obliquely on the thickened margin of the peristome. The structure of these blades is very different from that of the membranelles of other ciliates and does not at all resemble that in either the Ophryoscolecidæ or the Hypotrichida. For this reason it is apparent that the Tintinnoinea have only distant relations with these groups, although

Hofker (1931b) claims close connections between the hypotrichs and tintinnids on account of the supposed likenesses of the motor organelles.

Each membranelle is made up of adjacent laminæ, each consisting of a narrow, dense, vertical rodlet and a thin, wide, hyaline sheet. In cross-section the sickle-shaped lamina contains (1) a sticky enveloping peripheral covering; (2) a ground substance in which are (a) five or six fibrils in the blunt outer end of the rodlet, and (b) a single fibril on the convex side of the hyaline sheet. The basal granules of these fibrils are connected to the adoral fibril, which arises from the neuromotorium. In Stenosemella, at the inner edge of the base of each membranelle, above the point of origin of the accessory comb is an erect, granular, triangular organelle, the basal part of which is continuous with the distal rod of the membranelle by the granular basal portion of the latter.

It is these elaborate structures in the adoral region which constitute the motor mechanism which the daughter schizonts utilize at binary fission in shaping into the new lorica the still plastic secretions poured out from the gullet. The duration of the plastic period is unknown. The lack of uncompleted loricæ indicates that it must be brief. Many features in the structure of the circumoral and aboral parts of the lorica suggestive of ciliary action will be noted in the discussion of the varied genera of the Tintinnoinea.

Morphology of the Lorica

The Tintinnoinea are lorica-builders. Normally they live only in a lorica, or house, which they abandon only under adverse conditions. This is usually much larger than its occupant, its cavity being up to ten-fold the volume of the animal, and the wall, thin and delicate, as in most genera of Tintinnidæ, becoming more voluminous only in species having loricæ of great delicacy of structure, as in Climacocylis. The specific gravity of the lorica is not much greater than that of sea-water, so that it does not add to the difficulties of flotation by over-weight.

The form of the lorica is very divergent in the various families. It resembles a cup, a tube, a nail, an acorn, a pointed horn, a spirally-wound horn, or a vase. Some are open at both ends, as in the subfamily Salpingellinæ, and in the genera Leprotintinnus, Laackmanniella, Eutintinnus, and most species of Climacocylis. However, in most genera the oral end is widely open and the aboral closed, sharp or bluntly rounded, and often prolonged in a solid or hollow aboral horn.

Some loricæ are entirely formed by a spiral lamina as in Coxliella, some species of Tintinnopsis, and Climacocylis, while in others the spiral lamina is confined to a few narrow turns of the same texture as the bowl, as in Favella. There are still others in which the anterior portion only is composed of a hyaline ring (Stenosemella) or of a hyaline spiral band (Laackmanniella and Codonellopsis), and the posterior part of a more or less rounded coarsely alveolar bowl. Annular or spiral structures are almost unknown in a considerable group (Tintinnidæ, Undella).

The lorica of the Tintinnoinea presents numerous and varied examples of the biological phenomenon of repetition of similar structures, in both horizontal and vertical directions. Structural repetitions in the vertical direction are directly related to the ciliary membrane, the spiral adoral membranelles, and the spiraling movements of the animal. The results are seen in the spiral lamina forming repeated turns in the collar of Codonellopsis, the whole lorica of Coxliella, and the anterior part of the lorica of some species of Tintinnopsis. In other types of loricæ, such as those of Ptychocylis, Metacylis, Undellopsis, Amplectella, and Xystonellopsis, annular structure is found instead of a spiral one, and the annuli are repeated anteriorly only, as in Xystonellopsis, or even throughout the whole lorica, as in the subgenus Undellicricos. They are repeated more frequently and formed with greater perfection in the anterior region, and contain less material and are less perfectly formed posteriorly. There is thus in the annulation a vaguely defined axial gradient fading out in an antero-posterior direction.

The leading part in shaping of the spiral structure of the lorica is enacted by the large lateral ciliary membrane, whose position favors its aiding the adoral membranelles in laying down the extruded lorica-forming substance in a spiral direction. This powerful organelle is present in the Tintinnididæ, Codonellidæ, and Codonellopsidæ, and in these families there is some evidence that the ciliary membrane actually does act something like a trowel (Hofker, 1931b, figs. 3, 25, 27, and 48). The ciliation of the Coxliellidæ is inadequately known, but the pronounced spiral organization of the lorica of that family suggests that a ciliary membrane may be present in it also. Those families in which the organelle is definitely known to be present are, significantly, those in which the lorica is predominantly spiral.

In the Ptychocylidæ, Rhabdonellidæ, Xystonellidæ, and Tintinnidæ a ciliary membrane is lacking, and vertical modifications of structure are dominant. The Cyttarocylidæ occupy an intermediate position, and there are, at least in *Cyttarocylis acutiformis*, numerous short

membrane-like organelles just below the adoral membranelles. There is thus a correlation between the structure of the two types of lorica and the two types of ciliary organization.

A unique coordinated repetition of several dissimilar seriated parts of the aboral region is exhibited in Xystonellopsis in which there occurs in the lorica in an antero-posterior seriation the bowl, pedicel, knob, and lance. In two species, *clevei*, and less completely in *laticincta*, the pedicel and knob are each serially repeated, the posterior duplicate of each being both shorter and narrower than the anterior. The knob alone is repeated in *paradoxa* and *conicacauda*. A form of diversified repetition also appears in the Codonellidæ in the zonation of secondary and tertiary structure of the wall of the bowl and in the zonal arrangement of included coccoliths, as illustrated in *Codonella acuta* (Plate 2, fig. 8).

The lorica of the Tintinnoinea has vertical structures as well as transverse. These take the form of the vertical striae of Laackmanniella, Protocymatocylis, Cymatocylis, Favella, *Petalotricha foli*, Bursaopsis, Canthariella, and Steenstrupiella; the anterior striae of Dadayiella; the aboral wings of Favella; the major ribs of Epicancella; the free lines of Epiplocylis; the vertical or slightly spiral ribs of Protorhabdonella, Rhabdonella, Rhabdonellopsis, and Epicranella; the striæ on the pedicel of Xystonellopsis; the vertical ribs between the anterior pair of rings in *Xps. ornata*; the vertical mullions of Dictyocysta, and Stelidiella; the fins or angles of Amphorella, Amphorellopsis, Odontophorella, Ormosella, Stelidiella, and Daturella; and the posterior fins of Salpingella, Rhabdosella, and Salpingacantha.

This type of repeated vertical structures grades towards the flatter spiral type included in the horizontal structures. Some of the more spirally inclined linear striæ, etc., may be the result of membranelle action in much the same way as are the spirally formed collars. It is quite probable that the activities of repeated ciliary lines during lorica formation on the surface of the body, as well as that of the repeated membranelles, are concerned with the positions and numbers of these repeated vertical structures.

The numbers and positions of these repeated structures of the lorica are so distinctive of genera, and in a few instances of species or groups of species, that they must be interpreted as the result in large part of the distinctive and characteristic functioning of somewhat similar, if not in some cases apparently identical, structures. This repetition in structure and function thus assumes an aspect of functional memory, whatever that may be. The finer structure of the lorica has been very

thoroughly investigated by Daday (1887b), Biedermann (1893), and Brandt (1907).

By far the most important of the foreign materials used in building or strengthening the lorica are the coccoliths of the flagellate family Coccolithophoridæ. These minute organisms, which are widely distributed in tropical seas along with the Tintinnoinea are one of the principal sources of food of some of these ciliates. Their skeletal buttons, or coccoliths, form the most common extraneous materials detected in the wall of the lorica. In most instances the species feeding on the Coccolithophoridæ make use only of certain kinds of coccoliths, even in localities in which others are available. Thus it is probable that the ciliates select the given flagellate used as food and reject the others. Another tintinnid in the same locality may feed upon other flagellates, or at least utilize other coccoliths in its lorica.

The chemical make-up of the lorica of the Tintinnoinea has been investigated in only a few genera. The early experiments of Fol (1881) eliminated the presence of all but the quite inadequately defined "chitin." Entz, Jr. (1909b) was able to show clearly that the loricæ of some species at least gave a characteristic color reaction with the well known xanthoprotein test. He concluded that the lorica is made up of "irgend einem dem Keratin ähnlichen Eiweissderivat." Tests in our laboratory made by Dr. M. J. Kopac with various reagents, including Millon's, gave positive reactions for xanthoprotein in the lorica of at least two species — *Favella franciscana* and *Leprotintinnus neriticus*.

Casual observations have been offered previously in connection with a discussion of the method of lorica formation (Kofoid, 1930). At least five hypotheses have been suggested, as follows: — According to Entz, Sr. (1885b), the lorica of *Tintinnidium fluviatile* is formed by a division of the previously existing one into two new ones, the anterior animal taking over the anterior half, and the posterior daughter the posterior half. This author clearly figures in a very convincing manner (pl. 13, fig. 3) this partitioning of the jelly-like lorica of this one species. Somewhat like this observation is the suggestion advanced by Meunier (1910, p. 115) according to which the parental lorica is broken down at fission and reworked by the daughters. Entz, Jr. (1909b, pp. 119–123) and Busch (1925) suggest that the lorica is formed by a sort of "Häutung" or surface secretion and subsequent peeling off from the outer surface of the animal at the time of division. Busch (1925) and Hofker (1931a, b) saw in certain subsurface vacuoles of the cystosome a source of material which could be used in this manner.

Jörgensen (1924, p. 63) found loricæ which suggested that elongated species, such as the lance-tintinnids might be formed in a different way. "It seems to me probable that we have here loricæ, developed during, or immediately after, a fission, for some or another reason not passing normally on to full development of the newly created loricæ . . . One might also imagine that — by a conjugation between individuals with such very long loricæ as in *Rhabdonella spiralis* — similar short provisional loricæ were formed, later to be finished or left." He continues, ". . . we should here have a proof that the loricæ are developed from the mouth backward, and not in the shape of helicoidal bands . . . Moreover, that a later stretching of the wall, when still far from being finished, takes place to some — considerable? — extent, or a process, apparently giving the same result as if the different parts (or levels) of the young lorica continue growing (developing in size) for some time after being secreted from the animalcule." It seems, however, very difficult to see how a non-living system would continue to grow or develop into so characteristic and well regulated a pattern as that characteristic of the species of the Tintinnoinea, especially when its non-living structure has at all times so little contact with the animal as does the lorica of a tintinnid. Most interesting are the observations made by Schweyer (1903) on *Eutintinnus apertus* and extended later (1909) in his general paper to *Favella ehrenbergii*. This investigator found that the laterally developing peristome of the new posterior daughter grew out as a sort of "bud" prior to binary fission and that it formed around itself a hyaline subnuchal structure, or ring. Favella, as binary fission approached, threw out an irregular cloud of material of prismatic structure like the lorica in consistency.

The lorica produced by the secretion, which forms a ring around the animal described above by Schweyer in the living animal, might be formed either as a spiral band or as an annular structure. The evidence of such bands is frequently found in many non-annulate forms, such as, for instance, in *Tintinnopsis dadayi*, *Tps. campanula*, *Tps. reflexa*. Indeed, the evidence from Schweyer's observations fits in very well with Jörgensen's suggestion that the lorica forms from the oral end backward.

The wall of the lorica resembles in some respects minimum area figures produced by soap films. Among loricæ which resemble these most closely are those of Eutintinnus, Codonella, Codonaria, Salpingella, Amphorella, and perhaps Cyttarocylis. Others are, however, less similar and resemble non-minimum area figures. Among such loricæ are those of Codonellopsis, Coxliella, and Favella. The origin of

the loricæ of the Tintinnoinea cannot be wholly explained with facility as a surface-tension precipitation-product by ordinary physical means, as can the shells of Foraminifera and thecate Amoebina. The reasons for this are several, viz.: the lorica is never at any stage closely applied to the body wall of the animal, as seems to be required by a simple physical explanation; the pattern of the microstructure of the wall of the lorica seldom shows evidence of strain due to surface action; the form of the lorica is such that its formation would be with difficulty duplicated by physical models; and the fact that external horizontal, as well as vertical, ribs, knobs, mullions, and the like are present, all of which are difficult to interpret as simple physical products. The widespread occurrence of prismatic microstructure in the wall lends itself more readily to a simple physical explanation of its alveolar patterning than do the diverse structural elements evolved in the evolutionary development of the lorica of the Tintinnoinea. For these reasons we reject the opinion that any sort of surface "Häutung" or stretching process will satisfactorily explain the formation of the loricæ of the Tintinnoinea.

In *Favella franciscana* and *Tintinnopsis reflexa*, Campbell (1927, 1929) has identified in the "chromidial mass" commonly found in these tintinnids prior to binary fission the source of the lorica-forming substance. Entz, Jr. (1909b, p. 178) suggested that the "chromidial mass" arose from the disintegration of one of the macronuclei at the time of fission. This, however, has been shown (Campbell, 1927) not to be the case in *Favella franciscana*, in which the granules arise from and within the cytoplasm, possibly from secretory portions, and do not involve destruction of the nuclei. Although the granules do occur in their vicinity, the nuclei are not shrunken, nor do they disappear.

The hypothesis that the granular siderophile material accumulated prior to binary fission in the anterior region of the animal near its mouth is the substance used in forming the lorica is proven by the following facts: (1) its structure is granular as if made up of material secreted by cytoplasmic activity; (2) its consistency is suggestively alveolar as if elaborated by secretion; (3) its appears just prior to fission and increases tremendously in abundance as this process proceeds; and finally (4), the position in which it forms with reference to the existing organelles, particularly the gullet, is such that it may be discharged by that organelle. No other sufficiently massive accumulation occurs in the animal except that of this material, and the accumulation is always prior to fission. The accumulation of siderophile lorica-forming granules is not peculiar to Favella. We have seen it also

in *Tps. dadayi*, *Tps. reflexa*, and in a wide variety of species belonging to the several families treated in this Report. It is probably general in the Tintinnoinea.

The Function of the Lorica

The function and the utility of the lorica are clearly associated with the pelagic mode of life rather than with protection. The rather delicate lorica can be of no avail against active hunters with effective mouth parts, such as the Copepoda. Generalized feeders, such as the salpas, capture large numbers of the medium and smaller sized Tintinnoinea. The dimensions of the lorica serve as a protection only against feeders on the nannoplankton which sift out the smaller organisms, as is the case with the appendicularians.

The evolutionary development of this preeminently pelagic group of ciliates suggests that the lorica has some utility as an organ of flotation. It is evident, however, that its overweight, however slight, merely adds to the expenditure of energy on the part of the occupant. The increase of surface of the lorica over that of the body of the animal is considerable. Except for differences arising from the contrast of a ciliated protoplasmic surface with that of the smooth or reticulated surface of the wall, it adds proportionally to the resistance encountered in rotation and locomotion, and thus increases the expenditure of energy for like movements over that of the same organism without the house. The specific surface per unit of volume of the naked ciliate is less than that of the loricate one. As an organ of flotation, the lorica might even be a hindrance rather than an adaptation, unless it is lighter than the protoplasm. Except in Climacocylis and some species of Tintinnopsis with a gelatinous matrix and delicate loricæ, the indications are that lorica and animal have nearly the same specific gravity, so that little or no levitation is in operation. It may, however, be used for *assistance in directed locomotion*, and its size be adapted to temperature conditions.

The food of the Tintinnoinea is found above the light floor of the sea. It is known to be horizontally stratified, and diurnal movement is probable in the case of some of the species utilized as food. The greatest abundance of the Coccolithophoridæ occurs in a narrow belt at the fifty meter level, as shown by Lohmann (1902). It is essential that the Tintinnoinea keep within the illuminated zone, and it is advantageous for them to live within the area of greatest abundance of food. Tropisms to degrees and changes in illumination, to different concentrations

of food organisms, and to gravity involve directed locomotion in response to stimuli. Observations on living tintinnids under the microscope indicate much erratic and little directed movement. Under less contact stimulus and in the natural environment of normal illumination, the freer action of constant stimuli such as light and gravity may give a better opportunity for directed locomotion. Entz, Jr. (1909b) noted a negative geotropism of tintinnids in a glass cylinder.

In the event of directed movement in locomotion, the lorica takes on considerable mechanical significance. Its shape at the two ends, its elongation, its superficial spiral structures, such as the spiral shelf of Climacocylis, the spiral lines of the Rhabdonellidæ, Xystonellopsis, and Salpingacantha assume an adaptive aspect. These modifications conduce to spiraling and continued locomotion in one direction. The lorica therefore seems to be an adaptive structure which is of assistance to these pelagic ciliates in maintaining their location within suitable levels of the sea and of shifting their location with changing stimuli. Possibly gravity and the direction of light are the major factors involved in adaptions for directed locomotion.

In the absence of overweight of the lorica, the increase in surface over that of the body proper resulting from the relatively larger lorica assists in flotation upon cessation of locomotion. It increases the time and decreases the rate of sinking. Ostwald (1903a, b). When the locomotor organelles temporarily or periodically become inactive, the spiral structures on the outer surface of the lorica tend to set up and maintain a spiraling movement on the part of the sinking lorica, and thus to delay and impede descent below the optimum level of food supply.

Evolution of the Lorica

The sequence of families in the following outline of our system presents our opinions as to the morphological relationships and evolution of the Tintinnoinea. This system is based primarily on the form of the lorica, especially upon the minute organization of its wall and the progressive development of specialized regions at and near the oral and aboral ends, shaped, respectively, by the anterior and posterior schizont at binary fission of the body. The posterior daughter retains the old lorica, and the new one is built by the two daughters after the model of the old. The new lorica is the result of a preliminary accumulation of a colloidal matrix substance which, when extruded into the sea water, hardens in a uniform or in a differentiated alveolar pattern. While it is still in the plastic condition the stereotyped behavior of the

mobile organelles, of the lateral ciliary membrane (when present), and of the two daughters as a whole, shape the forming lorica into the ancestral pattern. The structure of the lorica is dependent upon a specific secretion and an inherited type of behavior of specific parts and of the bodies as a whole, of the two daughters during their changing relations prior to, and throughout, binary fission.

The results of these lorica-forming activities show varying degrees of uniformity. In some species of Tintinnopsis having amorphous aggregates of alveolar lorica-forming substance attached, or incorporated in, the lorica, and in the genus Climacocylis with its exceedingly tenuous, delicate, and very coarsely alveolar loricæ, there often is great diversity of aggregation, especially at the aboral end in the latter genus, though certain features of the basic pattern remain much more constant. On the other hand, the loricæ of such genera as Eutintinnus and Proplectella will show an astounding uniformity within a collection or under uniform environmental conditions. Temperature modifies dimensions, especially length, probably by affecting the functional rate and amount of lorica-forming secretion and the time within which the lorica is completed. In a general way, loricæ are smaller within the species in warmer waters than they are in colder.

On the whole, and in the face of environmental influences, the loricæ of a species show a remarkable adherence to type. Our drawings, selected to show extremes of variation within the species, a few of which have been reproduced, have been significant in the matter of demonstrating this adherence to type. The influence of variations in the *amount* of lorica-forming material upon the structure of the lorica is evident in the more highly differentiated loricæ, especially those with repeated rings or knobs, as in the Undellidæ and Xystonellidæ, in which the amount of substance in one or more of the repeated rings or knobs may be unusually variable. The influence of the amount of secretion may also be seen in the varying lengths of terminal or near-terminal structures, such as the pedicel and aboral horn.

The system of the Tintinnoinea as conceived by us has as its foundation the family Tintinnididæ with simple cylindrical or subcylindrical loricæ, with a very delicate, almost amorphous matrix and, at the most, but a feebly spiral structure. The lorica is here in its simplest form. It is possible that the open aboral end is a more primitive condition than the closed one widely prevalent in higher families. This open end occurs also in Laackmanniella, an antarctic genus of relatively simple type, and in the crudely organized genus Climacocylis. It also reappears (or survives?) in the subfamily Tintinninæ of the most highly

specialized family of the whole suborder, the Tintinnidæ. There is an aboral canal in the aboral horn in Favella, and in the families Rhabdonellidæ and Xystonellidæ, but this may be only an adaptation for a connecting protoplasmic strand joining the two daughters during the completion of the complicated aboral end of the newly forming lorica.

The family Codonellidæ is a very widely differentiated one, but is connected throughout by such progressively differentiated genera and species that to break it up would do violence to its unity. In Tintinnopsis we find the unifying characters of the agglomerated wall, closed aboral end, and in some species a faint spiral structure. Its simplest loricæ, such as those of *Tps. rotundata*, intergrade with Tintinnidium. Within the genus some of the structures characteristic of the other genera of the family emerge, such as flaring collar, rotund bowl, and tapering aboral horn. The genus Codonella advances to a neatly differentiated alveolar wall, collar, nuchal constriction, and bowl; Codonaria adds the suboral cone superposed above the collar; and Codonopsis develops the suboral ledge. The aboral horn is scarcely developed in this family, and there is no hyaline spiraled collar.

The family Codonellopsidæ adds the spiraled hyaline collar, counterbalanced as it lengthens by the elongation of the aboral horn. The genus Laackmanniella retains the primitive features of a subcylindrical bowl and open aboral end characterizing Leprotintinnus in the Tintinnididæ, but Codonellopsis has the bowl and aboral horn of the higher species of Codonella.

The family Coxliellidæ is one in which spiral structure is very highly emphasized, appearing in the whole or greater part of the lorica. In this respect it is derivable from the spiraled loricæ of Tintinnopsis, but lacks agglomerations in Coxliella, and adds a spiral shelf in Climacocylis. The latter genus retains the agglomerated structure of Tintinnopsis and the open aboral end of Leprotintinnus. In the subfamily Metacylinæ the spiraling is restricted to the suboral region, the wall is freed from agglomeration, the aboral end is closed, and the alveolation of the lorica is reduced. In this family the development of the spiral lamina in the formation of the lorica reaches its culmination in the suborder. The Coxliellidæ thus represent a lateral development from the lower Codonellopsidæ.

The family Cyttarocylidæ forms another rather isolated offshoot from the collared type of the Codonellidæ, such as *Tintinnopsis schotti* or *Codonella acuta*, with an aborally pointed bowl, nuchal constriction, and shelf. Its distinguishing characters are in its regularly reticulated pattern of wall structure and its more conical bowl.

The family Ptychocylidæ is primarily composed of circumpolar Tintinnoinea in which a series of characters uniformly more highly developed in the higher families appear in varying degrees of emergence, from a mere trace to a well developed state. At first sight the family seems incoherent, but its unity will appear more clearly when its basic position is analyzed. In the first place, its most primitive genus, Porœcus, is derivable from cylindrical types of Tintinnopsis, such as *Tsp. beroidea* or *Tps. strigosa*. There are, however, no agglomerations on the wall and coccoliths are utilized. The prophetic characters in this simple type of lorica are that (1) the aboral horn, when present, tends to be stout, as in some Ptychocylis and some Cricundella (Undellidæ); (2) incipient annular expansions of the cylindrical lorica appear in *Porœcus annulatus*, as also in Favella and Ptychocylis, and in a highly developed condition in the Undellidæ (Amplectella, Cricundella) and Xystonellidæ (Xystonellopsis); (3) the elongation of the bowl progresses within the family in Favella, and especially in Parafavella and some species of Cymatocylis, and attains its highest development outside of certain genera of the Tintinnidæ, in the related families of Rhabdonellidæ and Xystonellidæ; (4) the development of the aboral horn, which is only feebly evolved in Porœcus and Ptychocylis, reaches a higher development in Favella, and especially in some species of Cymatocylis, within the family, while in higher families, such as the Rhabdonellidæ and Xystonellidæ, it is a fairly constant and often highly developed feature of the lorica; (5) the circumoral structures, lacking in Porœcus and, in part, in Favella, are variously developed in Cymatocylis and Ptychocylis with a slight rim, channel, or denticulate crest, but never to the extent that the suboral region is elaborated in the Rhabdonellidæ and Xystonellidæ, and the denticulate crest in Parafavella and denticulations in the Petalotrichidæ; and, finally, (6) the structure of the wall is rather primitive without marked reticulations, but often with feeble longitudinal plications, as in Ptychocylis and especially in Cymatocylis, but never so highly developed as the free lines of the Epiplocylidæ, or the ribs of the Rhabdonellidæ. The Ptychocylidæ are thus a rather basic family from which the Epiplocylidæ, Petalotrichidæ, Rhabdonellidæ, Xystonellidæ, and Undellidæ may be derived. The characteristics of all these families are foreshadowed in the Ptychocylidæ.

The family Epiplocylidæ is formed by a coherent group of three genera, Epiplocylis, Epiorella, and Epicancella, all characterized by a stout, goblet-shaped bowl with incipient or stout aboral horn, and a wall with heavy reticulations aborally and a feeble development of free

longitudinal spiral lines. Epiplocylis has no circumoral development beyond a prophetic suboral thickening, but in Epiorella and Epicancella the suboral collar with shelf and channel is variously developed, as in some of the Rhabdonellidæ and the Xystonellidæ. The complete disappearance of the aborally located reticulations would give rise to a short, Parundella-like (Xystonellidæ) or Proplectella-like (Undellidæ) lorica. The disappearance of the cross-reticulations and conservation of the full-length spiral lines in Epicancella would give rise to a short-bowled lorica of the *Rhabdonella amor* type. There are, thus, in the Epiplocylidæ definite structural features relating this family to the three higher families, Rhabdonellidæ, Xystonellidæ, and Undellidæ. It is intermediate between the Ptychocylidæ and these three.

The family Petalotrichidæ is rather a heterogeneous group made less diverse by the transfer, introduced in this paper, of Metacylis with spiral collar, to the Coxliellidæ. The distinguishing characters are the hyaline or minutely alveolar wall, the more or less primitive form of suboral structures, the stout, bowl-shaped lorica (elongated only in *Petalotricha foli*), and the circumoral denticulations (lacking in Craterella and feebly developed in Petalotricha). This family may be regarded as an offshoot of (1) minute tropical genera with cup-shaped loricæ (Craterella, Acanthostomella) from the Ptychocylidæ, without higher derivatives, and (2) a group (Petalotricha and Wailesia) with larger, more elongate loricæ characterized by small surboral fenestral and longitudinal striæ. The shape of the lorica and form of the collar of Petalotricha resemble those of the Cyttarocylidæ, whereas in Wailesia the larger suboral windows are prophetic of the loricæ of the Dictyocystidæ. This lack of unity in the family Petalotrichidæ suggests that it is a composite in part derived from the Ptychocylidæ, and in part from the Cyttarocylidæ.

The family Rhabdonellidæ, on the other hand, is a unified and compact group, characterized almost throughout by an elongated lorica and a wall with primary and secondary prisms only, and always with longitudinal striæ or ribs on the whole lorica. In it the tendency to form striæ, seen in the Ptychocylidæ in Cymatocylis and Ptychocylis, and in the Petalotrichinæ, reaches its culmination. The family is a dominant one in tropical seas, where it attains considerable speciation and great numbers of individuals. The progress within the family is considerable, from the small, simple species of Protorhabdonella to the large species of Rhabdonellopsis with well developed circumoral structures, aboral knob and horn, and great elongation of lorica.

The family Xystonellidæ is likewise a dominant one in the tropical

plankton, except for Parafavella of Arctic seas. It differs mainly from the Rhabdonellidæ in the absence of striæ on the lorica, except for lingering remnants on the pedicel. It retains the simplified hyaline wall with only primary alveoli in Parundella, but has large secondary prisms in Xystonella and Xystonellopsis; evolves the circumoral region from the primitive unmodified state in Parundella to the elaborate rim, gutter, and repeated rings, even with vertical bars, in Xystonellopsis; and also progresses from the simple immature lorica of *Parundella minor* to the elongated, massive, and very complex *Xystonellopsis ornata.* The genus Parafavella is an appendix to the family with reticulate wall and denticulate rim. It was placed here primarily because of the highly developed secondary prismatic wall and aboral horn. Its relationships to Favella (Ptychocylidæ) are indicated by the shape of bowl and horn, toothed oral rim (scarcely evident in Favella), and structure of the wall (less prominent in Favella). Parafavella is a transition genus between the Ptychocylidæ and the Xystonellidæ.

The family Undellidæ is largely a tropical one, usually of small size, simple structure, with cup- or goblet-shaped hyaline lorica. The wall lacks secondary prisms and striæ, possibly secondarily derived from a Porœcus condition. Its inner and outer laminæ are very distinct and the intermediate layer is sharply defined but usually not clearly prismatic. The structure of the lorica is exceedingly simple in Proplectella and Undella. Amplectella, Amplectellopsis, and Cricundella add repeated rings to the shaft of the bowl, and Undellopsis adds a suboral ledge. Within the family, and even within some of the genera (Amplectella, Cricundella, and Undellopsis), there is a progressive evolution of annulation, seen also in Xystonellopsis. A tendency toward the Undella type of lorica may be seen in Porœcus (Ptychocylidæ), in the upper part of the bowl of Epiplocylis (Epiplocylidæ), in the small size, hyaline wall, and cup-shaped lorica of the Craterellinæ (Petalotrichidæ), in the shape of the small lorica of Protorhabdonella (Rhabdonellidæ), and in the hyaline laminate wall and the shape of lorica of the smaller species of Parundella (Xystonellidæ). The relationships of this unique family are most clearly defined with the Xystonellidæ, from whose simplest representatives it may have been derived.

The family Dictyocystidæ is one of the most neatly distinguished and strikingly uniform families of the Tintinnoinea. It contains only two genera, Luminella and Dictyocysta, both with a lorica with a globose bowl and a collar with windows. The bowl and its wall and the shape of the collar relate the Dictyocystidæ to the simpler species of Codonella, such as *C. nationalis,* but the hyaline structure of the collar

relates it to the Codonellopsidæ, from which it differs in the substitution of vertical subdivisions for spiral. The genus Luminella forms a connecting link with the Codonellidæ. The genus Dictyocysta, on the other hand, exhibits two significant features which appear to be prophetic of the Tintinnidæ, namely, the hyaline, homogeneous structure of the collar resembling the basic wall structure of the Tintinnidæ, and the vertical ribs of the collar. Vertical structures appear in the Tintinnidæ in the rings, striæ, or facets of Bursaopsis, Amphorella, Steenstrupiella, Amphorellopsis, Odontophorella, Dadayiella, Ormosella, Stelidella, Daturella, Salpingella, Salpingacantha, and Epicranella. The significance of the change from the spiral to the vertical basis of structure is so important that we place the Dictyocystidæ remote from the ancestral Codonellidæ and near to the Tintinnidæ.

The Tintinnidæ are regarded by us as the apex of evolution in the Tintinnoinea. The reasons for this allocation are as follows: (1) The hyaline, homogeneous wall is the most highly refined type of secretion. The coarse alveolation and agglomeration are characteristic of the lower families. (2) The family is very highly diversified into twenty genera with loricæ of very diverse size and pattern. It contains one-third of all of the genera in the suborder, and 128 of the about 700 species described. (3) It contains some of the most abundantly and widely represented species of the Tintinnoinea. (4) It contains the largest eupelagic species in the Tintinnoinea, as well as many of the very small ones. (5) Although the morphology of the lorica is remarkably simple throughout the family, many of the genera attain a refinement of proportions and pattern comparable to the studied simplicity of perfection of classic architecture.

The evolution, in the Tintinnoinea, of the lorica, a house actively shaped from a secretion, is based on an accompanying evolution of a coordinated mechanism in the body of the ciliate composed of cilia, membranelles, and accessory lappets, tentaculoids, and myonemes, an integrating neuromotor system, and specific secretions, upon all of which is built up a series of types of behavior, each resulting in a specified type of lorica. The system of classification here used rests upon this foundation, the most striking characteristic of the Tintinnoinea.

CORRELATIONS OF FREQUENCY WITH STRUCTURAL EVOLUTION

The relative degrees of evolutionary development within a series of systematic categories such as families and genera, may be inferred from relative structural differentiations within them, relative numbers of genera and species, geographic range and area, and their relative contributions to the total representation of the group in representative areas.

The generalized types of loricæ are those which retain more of the primitive structure, with a simple, stout bowl shape, more or less loosely organized alveolar wall with spiral structure evident throughout or locally, with structural elaboration in circumoral and aboral regions and often, but not always, without aboral horn or elongation of bowl. It will be of interest to apply these criteria to the subdivisions of the Tintinnoinea.

The loricæ identified in the eighteen dominant genera of the Tintinnoinea of the Eastern Tropical Pacific are distributed as follows in ten of the thirteen families: Codonellidæ (Codonella, 451, Codonaria, 323), total loricæ recorded in family, 910; Codonellopsidæ (Codonellopsis, 1175) (1215), Cyttarocylidæ (Cyttarocylis, 701), Epiplocylidæ (Epiplocylis, 1589; Epiorella, 657) (2322), Rhabdonellidæ (Rhabdonella, 2747; Rhabdonellopsis, 1478) (4342), Xystonellidæ (Xystonella, 677; Parundella, 335; Xystonellopsis, 896) (1908), Undellidæ (Proplectella, 805; Undella, 313) (1322), Dictyocystidæ (Dictyocysta, 1220), and Tintinnidæ (Amphorella, 854; Dadayiella, 1150; Eutintinnus, 1383; Salpingella, 297) (4056). The other four families, Tintinnididæ (not represented), Coxliellidæ (4 genera) (479 loricæ), Ptychocylidæ (5) (57), and Petalotrichidæ (3) (288) are all feebly represented numerically, if at all. They contain relatively simple, more generalized genera, have less specialized wall structure, less elongation, less circumoral and aboral differentiation (with a few exceptions), and retain more primitive spiral structure than the ten dominant families. They are also less definitely tropical in occurrence and distribution.

The Tintinnididæ are not represented in the collections of the Expedition, and are polar or fresh-water in distribution. The Coxliellidæ are bipolar in distribution and have relatively few species invading or resident in the tropics. The Ptychocylidæ are still rarer in the tropical seas, and are mainly arctic in distribution. The Petalotrichidæ contain a northern element, are abundant in colder seas but not in tropical.

In general, the polar Tintinnids are less highly specialized and less diversified than the tropical.

The distribution of species among the six classes in the relative-frequency lists throws light upon the degrees to which different genera form the Tintinnid population of the Eastern Tropical Pacific. Of the fifty genera, ten, namely, Albatrossiella, Amphorellopsis, Canthariella, Craterella, Epicranella, Epirhabdonella, Metacylis, Odontophorella, Prostelidiella, and Salpingacantha, contain only very rare species; six, Amphorella, Dadayiella, Dictyocysta, Epiplocylis, Rhabdonella, and Rhabdonellopsis, contain one or two abundant or very abundant species; and nine, namely, Climacocylis, Codonellopsis, Cyttarocylis, Dadayiella, Epiorella, Epiplocylis, Eutintinnus, Rhabdonella, and Rhabdonellopsis, contain one or two moderately abundant species.

If the genera are rated according to the weighted distribution of their species among the six classes of frequency, crediting one for very rare and up to six for the progressively more abundant ones, the sequence of genera and credit for each, for the ten leading genera, are: Xystonellopsis (51), Rhabdonella (45), Codonellopsis (37), Eutintinnus (36), Epiplocylis (29), Dictyocysta (28), Proplectella (26), Parundella (24), Codonella (23), and Salpingella (23). Only eight other genera rise above ten, namely, Cyttarocylis (19), Rhabdonellopsis (17), Undella (17), Dadayiella (13), Epiorella (11), Steenstrupiella (11), Undellopsis (11), and Xystonella (11). The remaining thirty-two genera are all below ten. The total ratings for species in the eighteen dominant genera (430) are over thirteen-fold those for the other thirty-two rarer genera.

RELATIVE FREQUENCY OF GENERA AND SPECIES

In order to present at least a quasi-quantitative record of relative frequency of individuals of the component species of each haul, records were made during the search of each collection of the number of loricæ seen of each species, up to a total of the first hundred. Thereafter each additional species detected at that station was merely recorded as 1%. The number of individuals of each species recorded in the hundred is thus the "frequency" at that station. These numbers have been used in making up station lists and describing the local distribution.

The frequency used in discussions of distribution of each species thus refers solely to the *relative numbers* of the different species at one station and does not indicate the relative numbers of the species in

question at different stations, or in different hauls. The number of specimens actually identified and recorded during the search, however, is given for each species, but it is not to be presumed that this total by any means represents *all* individuals in the collection, or even all of those identified. The hundred individuals were always counted from the catch of the No. 20 net, though a few additions to the station list were made from catches of the No. 12 net and from contents of stomachs of Salpa. These frequencies are used in the discussion of the occurrence of each species and are in the Station Records.

The following is a list by families of the actual total number of loricæ thus identified in each family in the collections of the Expedition:—

Number of Loricæ Identified in Each Family

Codonellidæ	910
Codonellopsidæ	1215
Coxliellidæ	479
Cyttarocylidæ	701
Ptychocylidæ	57
Epiplocylidæ	2322
Petalotrichidæ	288
Rhabdonellidæ	4342
Xystonellidæ	1908
Undellidæ	1322
Dictyocystidæ	1220
Tintinnidæ	4107
	18,871

The following table gives the total number of loricæ which were determined in each genus at all stations, the number of species of each genus identified in the collections, the range in numbers of loricæ per species in each genus, and the average number of loricæ per species in each genus. Any numerical discrepancies between these totals and frequencies reported for each species are due to the inclusion here of additional identifications.

SYSTEMATIC TABLE OF RELATIVE ABUNDANCE BASED ON LORICÆ IDENTIFIED

Genus	*Number of Loricæ Identified in Genus*	*Number of Species Recorded in Eastern Tropical Pacific*	*Range in Number of Loricæ Among Species of Genus*	*Average Number of Loricæ per Species*
Tintinnopsis	86	11	1–36	8
Codonella	451	15	1–157	30
Codonaria	323	6	3–170	54
Codonopsis	50	1	50	50
Stenosemella	40	1	40	40
Codonellopsis	1175	18	2–200	65
Coxliella	120	6	1–104	20
Climacocylis	335	6	1–321	56
Metacylis	11	3	1–7	4
Helicostomella	13	1	13	13
Cyttarocylis	701	9	2–264	78
Porœcus	33	4	1–24	8
Favella	24	2	10–14	12
Epiplocylis	1589	11	5–589	144
Epiorella	657	4	25–396	164
Epicancella	76	1	76	76
Craterella	33	3	1–5	4
Acanthostomella	67	4	2–18	17
Petalotricha	188	4	8–91	47
Protorhabdonella	112	4	1–77	28
Epirhabdonella	5	2	2–3	3
Rhabdonella	2747	19	1–781	145
Rhabdonellopsis	1478	5	3–1012	296
Parundella	335	14	1–51	24
Xystonella	677	6	1–404	113
Xystonellopsis	896	31	1–77	29
Proplectella	805	17	1–205	47
Undella	313	14	2–72	22
Amplectella	82	7	1–34	12
Amplectellopsis	23	2	1–21	12
Undellopsis	72	9	1–32	8
Cricundella	27	2	8–19	14
Dictyocysta	1220	17	2–638	72
Canthariella	9	3	2–4	3
Steenstrupiella	149	3	18–109	50
Amphorella	854	3	4–839	285

SYSTEMATIC TABLE OF RELATIVE ABUNDANCE BASED ON LORICÆ IDENTIFIED

Genus	*Number of Loricæ Identified in Genus*	*Number of Species Recorded in Eastern Tropical Pacific*	*Range in Number of Loricæ Among Species of Genus*	*Average Number of Loricæ per Species*
Amphorellopsis	11	6	1–4	2
Odontophorella	5	1	5	5
Albatrossiella	1	1	1	1
Dadayiella	1150	5	4–825	230
Ormosella	75	6	2–27	13
Brandtiella	12	1	12	12
Prostelidiella	1	1	1	1
Stelidiella	26	2	2–19	9
Eutintinnus	1383	19	1–458	73
Daturella	44	5	1–24	9
Salpingella	297	17	1–154	17
Salpingacantha	21	6	1–10	4
Rhabdosella	10	2	1–9	5
Epicranella	13	5	1–8	3

The data thus accumulated have involved certain difficulties and discrepancies, especially in those cases in which a species, originally conceived in a wide sense, was later in the course of our preparation of the manuscript broken up into several species by the removal of divergent groups of loricæ represented in our drawings. In all such cases only those loricæ which had been drawn were perforce included in the groups thus segregated off. All other records in the original analysis were left under the original specific name in the later restricted sense, with some resulting distortion in the relative numbers of the individuals in each of the final segregates.

The concept of each species in the inception of our work of necessity rested upon previously published figures or upon the characters of the first individual whose structure was analyzed and from which the first figure was drawn. As the allocation of the individuals to definite species progressed, our concept was sometimes modified by the detection of variants from the figure of the type individual. To meet this condition and to make available for purposes of comparison the structure of individuals of the same species from several localities, it became essential to sketch the outline of the most apparent and easily determined

parts of an increasing number of loricæ. Especially was this true in nearly all cases of the more abundant and generally more widely varying complexes. These groups of sketches, assembled in folders, constitute the great mass of data on which the manuscript has been based, and they form the sources illustrating the range of variability and the more aberrant types which are included within our concept of the species.

The fact should be noted that these habit sketches represented the range of variation observed and not the normal distribution within that range. The constant tendency, quite logically in the premises, was to make graphic record of all *aberrant individuals* even though these made up only a small fraction of the total representatives of the species. It follows from this that the diversities in a few individuals within the species are thus emphasized rather than the uniformities among the majority of them.

The families containing these dominant genera and species, in the order of the frequency rating of their genera, based on the six categories of the species in each, are the following: Tintinnidæ (133), Xystonellidæ (86), Rhabdonellidæ (89), Undellidæ (69), Epiplocylidæ (45), Codonellidæ (41), Codonellopsidæ (39), Dictyocystidæ (28), and Cyttarocylidæ (19).

It is noteworthy that the order of numerical importance corresponds closely with that of structural differentiation and general level of evolutionary status. The families containing dominant genera and species are, without exception, those of the higher levels of structural differentiation.

The Tintinnidæ are placed by us at the systematic apex of the Tintinnoinea because of the wide variety of generic types included in this family. No less than twenty of the sixty-two genera of the Tintinnoinea are found in it, and 141 of the 726 species. The next to the maximum number of loricæ, 4107, was recorded for this family, and its distribution is cosmopolitan. The family includes some of the largest as well as the smallest species in the Tintinnoinea. Some elongation of lorica is generally present and marked elongation is characteristic of the diversified, abundant, and considerably elaborated genera, such as Eutintinnus, Salpingella, and Salpingacantha. Both the suboral and aboral regions are areas of the most varied differentiation, and the outer surface of the bowl or shaft is often marked by longitudinal striæ, fins, angles, or ridges. The family is preeminently characteristic of tropical seas generally.

The Xystonellidæ and Rhabdonellidæ contain the genera and species

with loricæ of great elongation, large size, and elaborate differentiation of the suboral and aboral regions. They are also preeminently tropical in distribution and dominant in the Eastern Tropical Pacific with the exception of the Arctic genus Parafavella (23 species). There are three genera and sixty-six species in the tropical Xystonellidæ, and four genera and thirty-seven species in the Rhabdonellidæ, a differentiation rather strikingly less than that in the Tintinnidæ; the number of loricæ recorded in each was 1,908 and 4,342, respectively, but the numerical difference is not comparable to that in their respective degrees of differentiation. The Rhabdonellidæ have more surface differentiation than the Xystonellidæ, but the Xystonellidæ have a greater variety of aboral development.

The Undellidæ have six genera and sixty-eight species. The genera exhibit a considerable uniformity in a specialized wall structure, but little differentiation of oral and aboral regions, and a characteristic annulation of the shaft of the bowl best developed only in the more specialized genera. The species are often small and, though much diversified, they are rather simple in structure. In many species their small size has undoubtedly resulted in inadequate numerical representation in the net catches and station records.

The Epiplocylidæ have attained a complexity of wall structure and a highly characteristic pattern of bowl, with a circumoral differentiation comparable with that attained in the Codonellidæ, but with a relatively simple aboral region.

The Codonellopsidæ have evolved a spiral collar, characteristic bowl and wall structure, large size, but little structural modification of the aboral end.

The Dictyocystidæ are at about the same level as the Codonellopsidæ in structural evolution, but have vertical instead of spiral elements in the collar, and are all small.

The Codonellidæ have a characteristic wall structure, some circumoral structure differentiation, but very little aboral evolutionary advance.

The Cyttarocylidæ have a specialized patterned wall structure, but they have no circumoral structural specialization, only a little suboral or nuchal modification, and the aboral region is but feebly differentiated.

This summary shows that the sequence of the degrees of structural differentiation of the more abundant families of tropical Tintinnoinea approximates that of the relative frequency.

PREVIOUS INVESTIGATIONS OF THE TINTINNOINEA OF THE PACIFIC

No systematic attempt to study Tintinnoinea in the Pacific with adequate pelagic material has hitherto been made. Charles Darwin (1839, p. 15), in his classic *Voyage of the Beagle*, briefly noted cylindrical shelled infusorians which he found swarming in the high sea off Keeling Islands in the Indian Ocean, among an abundance of long thread-like algæ (Rhizosolenia). Undoubtedly some of these that passed in review under his microscope were species of Tintinnoinea, but since Darwin left no graphic record of his observations we are unable to identify a single one. The *Results of the Challenger Expedition* include no report upon this group of marine ciliates beyond a few casual references by Sir John Murray (1876) in the summary of results.

Hæckel (1887), in his *Report on the Radiolaria*, described and figured (pl. 56, fig. 13) as a radiolarian *Sethocephalus cuceryphalus*, the species later described by Brandt (1906) as *Cyttaroeylis plagiostoma* var. c., which was later identified by Kofoid (1912) as *Cyttaroeylis cuceryphalus*. This species was taken by the Challenger Expedition at Sta. 285, in the southern part of the South Equatorial Drift.

Cleve (1901c) listed 10 species from the Malay Archipelago, from Billeton to Timor.

Schmidt (1901) reported 21 species from the Gulf of Siam.

Kofoid (1905) described from neritic plankton off San Diego, California, 7 new species.

In his monograph on Tintinnoinea of the Plankton Expedition, Brandt (1906, 1907) has included references to material supplied to him, mainly from the southeastern part of the Tropical Pacific, by Drs. Kramer, Dahl, and Schott, from the Pacific side of the East Indies off Tonga, Sunday and Fiji Islands, Cook Strait, and New Zealand, south from Sydney. He lists 69 species in all from these localities. The 69 species and "forms" which Brandt found in his collections from the Pacific and its borders constitute 22.5% of the total number (301) which he includes in his monograph.

Okamura (1907) listed and figured from the Japanese Black Current near the Province of Tosa in Shikoku and from the Gulf of Tokio 20 species. Okamura further recorded (1912) 6 species from off the Province of Kii and at Zenizu.

Jörgensen (1924) recorded in his monographic "Mediterranean Tintinnidæ" a number of occurrences of 9 species of tintinnids from Pacific sources.

Wailes (1925) listed 23 species, 11 varieties and 2 forms collected in the spring and summer months from the North Pacific, largely in neritic collections at Departure Bay, Nanaimo; southwest in Puget Sound to Friday Harbor; and off San Juan Island, near the Strait of Juan de Fuca.

Campbell (1925a, 1925b, 1927) recorded in neritic plankton from off La Jolla and in San Francisco Bay, California, 9 species.

Hada (1932a) described 2 new species, from Mutsu Bay, Japan. In a later and more extensive paper, Hada (1932b) included 23 species collected in Taraika Bay and at 17 stations in the Sea of Okhotsk, at surface temperatures of 35°.4–41°.1. In a third paper Hada (1932c) records 35 species from the famous collecting grounds of Mutsu Bay and from near the Asamushi Marine Biological Station. Of the 42 species included in Hada's three papers (1932a,b,c) only 8 are included in our records. Since Hada's papers were received late, discussion of these species which occur in our material is not included in the systematic account of this Report.

Aside from Hæckel's misplaced Cyttarocylis and Brandt's and Jörgensen's miscellaneous records, the tintinnids thus far reported from the Pacific have been predominantly from neritic, subarctic, and temperate zone collections. The tropical oceanic collections of the Expedition are therefore from a field as yet but little explored.

I. TINTINNIDIDÆ Kofoid and Campbell

Tintinnoinea with tubular or diversely saccular lorica; with or without suboral spiral structure; rarely with collar or other suboral differentiations; aboral end sometimes expanded, never with fins, either open or closed; wall with primary prismatic structure only, in the main soft and gelatinous, with freely agglomerating particles of wall material and foreign bodies; 1–2 macronuclei, and 12–16 membranelles; in fresh water, brackish water, and the sea, where it is neritic. *Tintinnidium inquilinum* was included in the genus in our *Conspectus* (1929). It is here removed because of Apstein's (1915) allocation of *Tintinnus inquilinus* (O. F. Müller) to Tintinnus as its type species. This removal of the smooth-walled species *inquilinum* unifies Tintinnidium, leaving in the genus only loricæ whose walls are rough with agglomerations of lorica substance and foreign detritus.

Two genera included, viz., Tintinnidium Kent with closed aboral end and Leprotintinnus Jörgensen with open aboral end. Neither is present in Expedition material. Tintinnidium was established by Kent

(1882) and included *Tdm. marinum* (= *Tintinnus inquilinus*), *fluviatile*, and *semiciliatum*. Daday (1887b) added *mucicola* (Claparède and Lachmann) and *neapolitanum* Daday. Since *mucicola* was selected by us (1929, p. 9) as the type of the genus, we now reject this as the type and select in its place, *Tintinnidium fluviatile* originally included by Kent in the genus, in accord with Article 30, sec. 12a, of the International Code of Zoölogical Nomenclature. The best figures of the species are those of Entz, Jr. (1905, pl. 5, figs. 1, 2), who clearly indicates their essential characters.

The following species are included in the genus:— *Tdm. fluviatile* (Stein) Kent, *incertum* Brandt, *lacustris* (Entz, Jr.) Hofker, *mucicola* (Clap. and Lach.) Daday, *neapolitanum* Daday, *pusillum* Entz, Jr., *ranunculi* Penard, and *semiciliatum* (Sterki) Kent.

The name "*Tintinnidium*" *lacustris* was introduced into the genus by Hofker (1931b, p. 320); possibly it may also refer to *Codonella cratera* (= *Tps. lacustris* Entz. Sr.). Apparently he is quoting by *lapsus pennæ* Faure-Fremiet's (1924) *Tps. lacustris*, but the context suggests that he had in mind that author's *Tdm. fluviatile*. The *Tintinnopsis bottnica* figured by Hofker (1922, p. 170, fig. 78) is later (1931b, pp. 320–321, fig. 4) correctly assigned to Leprotintinnus.

II. CODONELLIDÆ Kent emended Kofoid and Campbell

Tintinnoinea with tubular, bowl- or cup-shaped lorica, with or without collar. Collar never spiral nor hyaline. With or without nuchal constriction. Bowl of diverse shapes, tubular, conical, and subglobular. Aboral end closed, except when open by seeming artifact. Aboral point or horn present in a few species. Wall of minute primary and much coarser secondary or even tertiary structures, regular or irregular in distribution, and of even or uneven sizes. Surface pattern sometimes definitely distinctive. Inner and outer laminæ poorly developed, if at all. Macronuclei 2–8, rarely 16. In fresh water, where but few occur, brackish water, and mainly in the sea, both neritic and eupelagic.

The family, founded by Kent (1882), had previously been suggested but not given systematic status by Hæckel (1873). Kent included in it only Codonella and Tintinnopsis. Kofoid and Campbell (1929) emended the family by the inclusion of *Codonella lagenula*, which Kent had assigned to his Tintinnodæ. The type genus of Codonellidæ is Codonella Hæckel (1873), though Tintinnopsis Stein (1867) was established earlier.

Four genera are included in the family as modified by us in this

Report, namely, Codonella, Tintinnopsis, Codonopsis gen. nov., and Codonaria, gen. nov. Of these, Tintinnopsis, the largest, contains 85 species, Codonella 28, Codonopsis 1, and Codonaria 8.

Tintinnopsis is the most primitive, and includes the most generalized species of Tintinnoinea. It has, on the other hand, an extraordinary differentiation and diversity of form, but lacks the inner and outer laminæ. It has, as positive features, a trace of spiral organization in some species, a less finely and less definitely organized wall structure, and irregularities due to adherent blobs of wall substance. This last character allies the genus with Tintinnidium and Leprotintinnus, but the form of the lorica of Tintinnopsis is generally very different from the less regular tubular ones of these latter two genera. Tintinnopsis so clearly intergrades with Tintinnidium that the status of the latter is at best rather tenuous. Tintinnopsis is neritic in distribution, mainly in polar and temperate waters, is scantily represented in the tropics, and only a few species are constituents of the oceanic plankton.

Codonella is more regular and unified in structure and has distinct laminæ in the wall. This genus is the most primitive of all oceanic genera. Its form is more like that of Tintinnopsis than that of other pelagic genera, and its wall structure is like that of Tintinnopsis, but more regular. It fills the place of the neritic Tintinnopsis in the oceanic plankton.

1. TINTINNOPSIS Stein emended Brandt emended Jörgensen

Wall without laminæ, with fine primary, and coarser secondary alveoli or prisms, often with adherent blobs. Loricæ variously tubular, conical, or ovoidal. Aboral end closed.

Tintinnopsis is a much differentiated genus composed almost exclusively of neritic species widely distributed around all continents. Its representation in the collections of the Eastern Tropical Pacific Expedition is too fragmentary to justify either morphological, revisionary, or adequate distributional treatment. Only 11 of the 85 species are found in the collections. The type species is *Tintinnopsis beroidea* Stein, emended Jörgensen, from the Baltic.

The 11 species recorded are:— *Tintinnopsis beroidea, fennica, karajacensis, mortenscnii, panamensis, plagiostoma, ornata, radix, sacculus, schotti,* and *rara.* Of these 11 species, 2, *ornata* and *rara,* are described for the first time in this Report.

Tintinnopsis beroidea Stein emended Entz, Sr. emended Jörgensen

Plate 1, fig. 1

Non *Tintinnopsis beroidea*, Hoek, 1902, pp. 131–132, pl. 5, fig. 2 (see *Tps. rotundata*).

Tintinnopsis beroidea, Hofker, 1922, pp. 173–174, fig. 82e (for fig. 82a-d see *Tps. parvula*); 1931b, *partim*, pp. 334–338, figs. 15e, 17a-d (for figs. 15a, b, d see *Tps. parvula*).

Lorica with long subcylindrical bowl and conical aboral end. Length 1.33–1.81 (1.58) o.d. (= oral diameter). Oral margin irregular, because of blobs. No collar. Bowl subcylindrical, an inverted segment of a cone (4–7°), 0.69–0.80 (0.74) t.l. (= total length), with posterior diameter of 0.88–0.90 o.d. Aboral end a cone of 75–90°, 0.20–0.31 (0.26) of total length, with convex sides. Aboral end pointed, or blunt, or with a hyaline axial or oblique spine 0.5–0.7 o.d. at tip, with color and refractive index of spines of Chætoceras, abundant in plankton at stations where this species occurs. The spine is peculiarly constant. A similar structure is in loricæ of *Tintinnopsis plagiostoma* (Calkins, 1902, fig. 47). Wall thin and irregular, due to blobs, with 16–19 secondary fields across bowl, and 21–29 from oral to aboral end. Animal with 20–34 membranelles and a single large, sausage-shaped macronucleus or two subglobular ones, and 1 or 2 globular micronuclei. Two nuclei indicate approaching binary fission.

Five loricæ: L.,[1] total, 43–45μ. D.,[1] oral 24–26μ.

At 3 stations in the Panamic Area, and in neritic collections off Taboquilla and Flamenco Islands, at the Panama anchorage, and from Acapulco Harbor; at 79–82 (80°.3); 36 loricæ.

Tintinnopsis fennica Kofoid and Campbell

Lorica tapering subcylindrical, tall bell-shaped, with short conical aboral horn. Length 2.5–3.0 o.d. Oral margin irregular, sometimes turned inward, with local blobs. Bowl formed of long anterior cylinder and aboral cone. Length of cylinder 0.5–0.6 t.l., or 1.4–2.0 o.d. Aboral cone a regular or asymmetrical, inverted cone (72–45°). Diameter at aboral end 0.24 o.d. or less. Aboral horn a stout inverted cone (20–43°), length 0.60–0.75 o.d., quite irregular and obscured by large accretions. Wall with irregular alveolar blobs, with 40 secondary prisms across one face and a finer network of 10 primary prisms within each secondary one.

[1] In these and subsequent measurements L. = length and D. = diameter.

L., total, 135; horn, 35. D., oral, 40; base of horn, 18μ.

At Panama anchorage; at 84°; 1 lorica.

Tintinnopsis karajacensis Brandt

Plate 1, fig. 2

Tintinnopsis karajacensis, partim, K. and C., 1929, p. 37, fig. 38. *Tps. karajacensis*, Vanhöffen (1897, pl. 5, fig. 28, is *Tps. levigata* K. and C., 1929, p.37). *Non* Linko, 1913, p. 5, pl. 1, fig. 2 (see *Tps. undella* Meunier).

Lorica elongated, subcylindrical, with broadly rounded aboral end. Length 1.84–2.30 o.d. Oral margin irregular, with blobs and a trifle inturned. No collar. The lorica with a long anterior subcylindrical bowl and an aboral hemisphere. Bowl 0.72–0.75 t.l., an inverted cone (5–8°). Posterior diameter 0.76–0.95 o.d. Aboral region 0.25 t.l., hemispherical, its shape obscured by blobs. Wall irregular, thin, with imperfect spiral laminate, with crude secondary polygons in a single layer and primary prisms in 2–4 layers. Animal with two globular macronuclei, and two micronuclei.

Two loricæ: L., total, 85–104. D., oral, 40–45μ.

At 2 stations in Mexican Current and from Panama Harbor; at 81–84°; 6 loricæ.

Tintinnopsis mortensenii Schmidt

Lorica small, inverted tall hat-shaped, with collar and bowl. Collar wide, horizontal, flat, at right angles to bowl. Diameter 1.17 t.l. Width from rim to periphery 0.5 of nuchal opening. Oral margin ragged. Bowl subcylindrical in anterior 0.66, flaring below collar, forming an inverted truncated cone of 10° in its anterior 0.5. Aboral end subhemispherical, pointless. Wall thin, uniform, encrusted with subregular blobs or coccoliths of *Pontosphæra huxleyi* on bowl and collar.

L., total, 53. D., collar, 46; bowl, 26μ.

At Sta. 4707 in Drift; at 72°; 1 lorica.

Tintinnopsis ornata sp. nov.

Plate 1, fig. 8

Lorica small, distinctive in its widely spreading collar. Length 1 o.d., or 1.71 nuchal diameters. Collar widely flaring, saucer-shaped, 0.18 t.l. or 0.20 o.d. Nuchal diameter 0.57 o.d. Oral margin uneven. Bowl with an anterior cylinder and an ovate subconical aboral region with a shoulder between the two. Anterior cylinder 0.28 of total length and

0.6 o.d. in diameter. Aboral region a convex inverted cone (67°), 0.58 t.l. Aboral end broadly rounded, with trace of point. Wall thin in collar, thickening in bowl and aboral cone, encrusted with coccoliths imbedded in wall on inner and outer surfaces. Four species are represented: — large *Coccolithophora leptopora* grouped around enlarged end of aboral region and smaller ones crowded aborally or included in collar; *C. wallichi* segregated in cylinder and collar; *C. pelagica* grouped about aboral end and in collar; and *Pontosphæra huxleyi* in aboral region and collar. No annular or spiral structure.

L., total, 40; cylinder, 11; aboral cone, 22. D., collar, 35; nuchal opening, 20; cylinder, 22; shoulder, 25μ.

At Sta. 4724 in Drift, at 79° (1 lorica).

Tintinnopsis panamensis Kofoid and Campbell

Plate 1, fig. 4

Lorica very much elongated, cylindrical anteriorly, expanded below, with long aboral horn. Length 6.10–7.40 (6.64) o.d. Oral margin entire or with blobs. Bowl with long anterior cylinder 0.40–0.55 (0.46) t.l., or 2.25–4.00 o.d., and a posterior inflated region 0.14–0.24 t.l. and 1.1–1.4 o.d. in width, tapering below in an inverted cone of 30–55°. Aboral horn 0.21–0.39 t.l., an irregular narrow cone of 12–17°, usually curved in continuation of spiral of wall, with characteristic irregular opening on one face of horn extending for 0.3–0.5 of its length. Aboral end asymmetrically pointed. Wall thin, of irregular, uneven secondary fields which contain primary prisms. Spiral lamina marked by outer buckling of wall, producing a ridge and furrows, and by lines of adherent blobs. Spiral passes orally in anti-clockwise direction with slope of 12°, with up to 17 turns between expanded part and oral margin, becoming less evident towards oral margin. A faint suture separates adjacent turns.

Three loricæ: L., total, 275–330; cylinder, 130–160; expanded portion, 35–50; horn, 100–150. D., oral, 45–50, expanded region, 52–60μ.

At Panama anchorage; at 81–83°; 52–75% loricæ. Type locality is Bay of Panama.

Tintinnopsis plagiostoma Daday

Lorica convex conical cup-shaped with no aboral differentiation. Length 1.0–1.1 o.d. Greatest diameter at squarely truncated or slightly inturned oral end. Oral margin uneven with adherent blobs. Bowl

forms whole lorica, a convex conical inverted cone changing from 25° near oral rim to 90° at acute or slightly rounded aboral end. Wall thin with many irregular, often large blobs of prismatic material. Animal with several globular macronuclei, and 24 membranelles as long as the oral diameter.

Two loricæ: L., total, 30–35. D., oral, 26–32μ.

At Sta. 4627 in Panamic Area; at 82°; 9 loricæ.

Tintinnopsis radix (Imhoff) Brandt emended Kofoid and Campbell

Lorica very much elongated, 4.55–6.55 o.d., narrow, with long anterior cylinder, posterior cone, and usually no aboral horn. Oral margin entire. Bowl a long anterior cylinder, 0.49–0.61 t.l., and a posterior inverted, asymmetrical cone (22–27°) 0.35–0.39 t.l. A few loricæ have an aboral horn 0.5 o.d. in length. Wall thin, with faint anti-clockwise spiral of up to 23 turns with slope of 6° but not on aboral cone or suboral region. Small surface flecks midway of band. Numerous irregular fields with primary prisms. Animal with 20–24 membranelles and 2 globular macronuclei.

Three loricæ: L., total, 228–256. D., oral, 44–54μ.

At 7 stations, at 3 and 4, respectively, in the Mexican Current and Panamic Area; at 78–84 (81°.8); 27 loricæ.

Tintinnopsis rara sp. nov.

Plate 1, fig. 7

Lorica rotund, bowl-shaped, with short, erect, cylindrical collar, spheroidal bowl, and no aboral point. Length 1.43 o.d. Oral margin entire. Collar 0.15 t.l., or 0.22 o.d. Nuchal diameter equals oral. Bowl spherical. Greatest diameter 1.43 o.d. No aboral point. Wall thin, uniform, with round or irregular blobs over whole surface.

L., total, 48; nuchal extension, 7. D., oral, 32; bowl, 45μ.

At Sta. 4742 in South Equatorial Current; at 77°; 1 lorica.

Tintinnopsis sacculus Brandt

Lorica moderately stout, anteriorly subcylindrical, posteriorly subhemispherical. Length 1.35–1.84 o.d. Oral margin entire or ragged. Anterior part of bowl is 0.5–0.7 t.l. Aboral end flattened or obliquely truncate for 0.3–0.4 o.d. Wall thin, with fine, primary prisms and coarse, faint secondary structure with 10 prisms across lorica and small

adherent flecks. Animal (Brandt, pl. 19, fig. 13) with two (or 8) large ovoidal macronuclei, 10 by 18μ, and 18 membranelles.

L., total, 70. D., oral, 38μ.

At 2 Sta. 4592 and 4598, in Mexican Current; at 84°; 2 loricæ.

Tintinnopsis schotti Brandt

Lorica urn-shaped, with flaring collar and pointed aboral end. Length 0.88 o.d. Collar short, wide, 0.2 t.l., inverted subconical (92°) or dished on upper surface. Oral margin in our lorica irregular, as though the occupant may have been caught while forming a new secondary cylinder above the nuchal rim. Nuchal diameter 0.7 o.d. Bowl short, subglobular, with anterior inverted subconical (13°) section 0.41 t.l., with posterior diameter of 0.62 o.d. or 0.88 of nuchal, and posterior inverted cone (90°) expanding below middle. Aboral tip bluntly pointed. Wall thick, decreasing toward aboral end and oral rim, with large, irregular, unequal secondary polygons, 23 across bowl and 28 from oral rim to aboral end. Whole surface more or less irregular due to blobs.

L., total, 62. D., oral, 70; bowl, 48μ.

At Sta. 4624 in Panamic Area; at 79°; 2 loricæ.

2. CODONELLA Hæckel emended

Codonella, *partim*, K. and C., 1929, pp. 51–52 (see also Codonaria).

Codonellidæ with stout urn- to pot-shaped lorica with external nuchal constriction, and/or internal nuchal shelf; divided into collar and bowl; collar never distinctly annulated (except in *lariana*), never with spiral structure, never hyaline, never longer than bowl, and never with oral crest; fenestræ, if present, irregular in size, and equatorial or scattered in location; coccoliths often incorporated in wall; pelagic, oceanic, or limnetic. Type species *Codonella galea* Hæckel, from Strait of Messina, the only species originally described by Hæckel and now retained in genus.

Very close to Codonaria, differing in lack of suboral cone and inferior development of nuchal constriction. Distinction between collar and bowl always discernible in Codonella, but not in many species of Tintinnopsis. Irregularities in wall and agglomeration of lorica material and foreign bodies, so evident in Tintinnopsis, are absent in Codonella, except in *aspera*.

Established by Hæckel (1873) with 3 species, of which only *galea* is

now retained, *orthoceras* being transferred to Codonellopsis, and *Campanella* falling into synonymy of *Tintinnopsis campanula*. Daday (1886) added 2 species, *annulata* (= *Coxliella annulata*) and *punctata* (= *Cod. cistellula*), and in a later paper (1887b) another, *bornandi* (= *Tintinnopsis bornandi*). He also (1887b) transferred to Codonella the questionable species *Tintinnus lagenula* of Claparède and Lachmann (1858), and also their *T. annulatus* (= *Tintinnopsis annulata*) wrongly to supersede *orthoceras* Hæckel. Brandt (1906, 1907) added greatly to our knowledge of Codonella from the rich oceanic material of the Plankton Expedition. It was the second genus treated in his monograph, and in it he developed fully his concept of the "Formenkreis" relations within the genus, with resulting systematic chaos and introduction of designation of varieties partly by Latin names and partly by letters. This was accompanied by specific designations for certain loricæ structurally no more distinguished than others which received only an alphabetical designation. Had he utilized many sketches to scale, as we have done, instead of a relatively few artists' finished drawings, he might have had a clearer concept of the specific assortments of his material. He recognized three form-cycles, designated as *galea, orthoceras*, and *ecaudata* groups, with *ostenfeldi* and *morchella* appended. In the *galea* group he included *galea* with vars. a-d, *nationalis* with vars. a-e, *perforata* with vars. a-b, *cistellula* with vars. a-d, and *amphorella* with vars. a-b. In the *orthoceras* group he included *orthoceras* with vars. a-l, *biedermanni*, and *brevicaudata*. In the *ecaudata* group he included *ecaudata* with one variety, *pusilla* with one variety, and *lagenula*. In his appendix he included *ostenfeldi* and *morchella* with two varieties. This makes a total of 46 ultimate systematic units distributed in the four categories of form-cycle, species, variety named, and variety only lettered.

In our utilization of Brandt's systematic units we have not followed his system of subordination of these units, partly on theoretical grounds, since it is by no means certain that degrees of structural difference represent accurately, by any method of assessment of relative values, corresponding degrees of genetic relationship and thus of systematic significance. Still more potent, in our opinion, is the practical matter of keeping the units of classification and of nomenclatural designation as simple as possible. In our *Conspectus* (1929) we utilized only genera and species as systematic units, and in this paper have arranged the species in series of related species of orthogenetic type but have avoided the introduction of these groupings into systematic nomenclature. As the result of our treatment of Brandt's systematic

units his 13 basic species are retained, including his typical *C. nationalis*, which is very close to Hæckel's (1873) *C. galea*, 23 of his varieties are raised to specific status, 12 are reduced in whole or in part to synonyms, and 7 of his units are split into one or more species either for specific status or reduction to synonyms. The details of these dispositions may be traced by the use of the index of our *Conspectus*.

Jörgensen (1924) removed the *Codonella orthoceras* form-cycle and the appended species *ostenfeldi* and *morchella* to a new genus, *Codonellopsis*, on the basis of spiral hyaline collar. We (1929) accepted these revisions and retained Codonella as thus limited. In this monograph we remove, to a new genus, Codonaria, all species with a suboral cone.

Since our *Conspectus* (1929) was published we have been able to examine the late Professor Ostenfeld's copy of Minkiewitsch's (1903) original paper containing his description of *C. relicta*, and are convinced that *relicta* is a valid species, distinct from *cratera* and not like *Stenosemella ventricosa*, as Jörgensen (1924) suggests, thus confirming our previous (1929) assignment.

Contains twenty-eight species, of which 15 are recorded in the Expedition material; of the 28, 16 were new, of which 9 are recorded in Expedition material. *Codonella sphærica* Carazzi (1900) is a *nomen nudum*. Subdivided into 6 series, as follows: — *cratera* series, including *cratera*, *lariana*, and *relicta;* the *brevicollis* series, including *brevicollis*, *laticollis*, *pacifica*, and *saccus;* the *acuta* series, including *acuta*, *aspera*, *galea*, *elongata*, *lagenula*, and *nationalis;* the *acerca* series, including *acerca*, *apicata*, *cuspidata*, *diomedæ*, *inflata*, *olla*, *perforata*, *robusta*, and *tropica;* the *acutula* series, including *acutula* and *poculum;* and the *amphorella* series, including *amphorella*, *rapa*, and *recta*.

Codonella acuta Kofoid and Campbell

Plate 2, figs. 1, 2, 5, 7, 8, 10, 12

Lorica moderately elongated, 1.38–1.6 (1.48) o.d. or 1.38–1.51 (1.44) d. bowl, with tall convex collar, stout bowl, and pointed aboral end. Nuchal constriction 0.71–0.91 o.d. Collar 0.21–0.28 (0.25) t.l., or 0.29–0.42 o.d., an inverted segment of an outwardly convex cone 23–30° (exceptionally 50°), 0.92–1.00 o.d. half way from oral margin to neck. Oral crest low, hyaline. Oral margin slightly flaring, entire, or minutely toothed. Bowl stout ovoidal, wider end anterior, 1.02–1.20 o.d., or 0.72–0.79 t.l., greatest diameter 0.92–1.12 o.d. at 0.55–0.64 t.l. from oral margin. Aboral end an inverted convex cone of 108–115°.

Aboral tip not protuberant, acute to broadly rounded. Wall with 2–3 layers of prisms, regular small secondary fields, sometimes with coccoliths of *Umbilicosphæra mirabilis*, *Coccolithophora pelagica*, and *Pontosphæra syracusana*. One lorica, from Sta. 4587, has adherent barrel-shaped flotation cylinders of Rhabdosphæra. Built into wall are smaller elliptical platelets of *Scyphosphæra apsteini* and numerous smaller coccoliths of *Coccolithophora wallichi*, 2–3 μ in length, filling greater part of wall. About 35 areas, 2–8 μ, across middle of bowl, smaller aborally. Primary structure in fields not filled with coccoliths. Closing-apparatus 13 unequal blades.

Twenty loricæ in 2 series, larger loricæ (series I) of this species, with one exception, occur in cooler waters, and smaller (II) in warmer. Series I: — L., total, 80–105 (91.4); collar, 20–28 (24). D., oral, 50–70 (59.9); neck, 40–54 (47.5); bowl, 52–74 (62.4) μ. Temperature at 6 stations from which these 10 loricæ were taken was 66–68 (67.5)°. Series II: — L., total, 80–89 (82.2); collar, 16–24 (19.8). D., oral, 53–60 (57.1); neck, 47–52 (49.5); bowl, 57–64 (59.7) μ. Temperature at 7 stations from which these 10 loricæ were taken was 75–84 (79)°. A rise of 11.5° in average temperature in *surface waters* is accompanied by a decrease of 9.2 μ in average length. The molecular friction in the lower temperature, 67.5°, should be about 1.58 of that at 79°, other factors being equal. It is obvious that adjustments in dimensions in loricæ from colder waters (91.4 μ), as against those in warmer waters (82.2 μ), are not in this proportion, but considerably less, a condition probably correlated with the fact that the species lives predominantly below surface at levels where differences in temperature are less than at surface.

At 20 stations, viz., at 2, 4, 11, 1, 1, and 1, respectively, in California, Mexican, Peruvian, and South Equatorial currents, Panamic Area, and Drift; at 66–84 (72.8)°; 74 loricæ.

Codonella acutula Kofoid and Campbell

Plate 2, figs. 4, 11

Lorica short, stout, cup-shaped, without neck, pointed aborally, 1.23 o.d. Oral margin irregularly serrate with 54 low, triangular teeth. Oral crest a low, erect, hyaline band. Collar not externally differentiated by nuchal constriction, its lower limits set by the wide, internally projecting nuchal shelf, 0.21 total length or 0.26 o.d. below oral margin. Lorica cylindrical, without taper in its anterior 0.58, but sides slightly irregular, due to local thickenings of wall. Bowl below nuchal shelf

0.79 t.l., or 0.98 o.d., cylindrical in anterior 0.5 and externally directly continuous with collar; in its posterior 0.5 short, wide, inverted, and convex subconical (95°); length 0.48 d., and sides somewhat convex. Aboral end an inverted cone (90°) with acute point. Wall of strongly developed secondary prismatic polygons, 30 across middle of bowl and 50 from rim to aboral end. In one lorica every field, except a few in periphery of collar, contained a coccolith of *Coccolithophora leptopora*, *C. wallichi*, or *Syracosphæra pulchra*. Fields subequal in middle of lorica, larger toward oral end, and a fourth as large at aboral. Wall of collar thickens internally evenly and concavely to wide nuchal shelf, 0.16 o.d. in thickness at widest part. Nuchal aperture 0.68 o.d. Shelf subtriangular in section, due to concave thinning of wall below it. Wall of bowl with 2–4 layers of polygons.

L., total, 86; collar, 18. D., oral, 70μ.

At Sta. 4640 in Panamic Area; at 75°; 3 loricæ.

Codonella amphorella Biedermann

Plate 2, fig. 14

Lorica gracefully urn-shaped, 1.77–2.11 (1.99) o.d., or 1.58–1.80 (1.75) d. bowl. Collar tall, turban-shaped. Bowl rotund, baggy. Aboral horn long, narrow, conical. Oral crest low, hyaline, incurved, band-like. Oral margin entire or ragged. Collar moderately tall, 0.20–0.23 (0.21) t.l., or 0.40–0.48 (0.43) o.d., expanding evenly to middle to diameter of 1.07 o.d., and contracting evenly below to neck, 0.78–0.88 (0.84) o.d., or 0.69–0.81 (0.74) d. bowl. Bowl truncate ovoidal, expanding from neck evenly and convexly at angle of 25° from vertical to maximum diameter at 1.15 o.d. or 0.39 t.l. from oral margin, contracting below in baggy subhemispherical aboral region. Aboral end produced in slightly concave, inverted cone of 115°. Aboral horn blunt cone of 24°, 0.19–0.28 (0.24) t.l., or 0.35–0.55 (0.48) o.d. in length, divided internally by cup-like transverse septum near middle. Wall variable. Loricæ at Sta. 4681, 4701, and 4705 have only small, subregular, secondary polygons without larger tertiary fenestration, with 25–30 fields across middle of bowl, and alike on both collar and bowl. At Sta. 4724 coccoliths of *Coccolithophora pelagica* occur in wall, and at 4705 polygonal meshwork was found in bowl from base of horn to neck, filled with large circular or tub-shaped coccoliths of an unknown species, with their inner ends smaller than outer ones, giving appearance of a double ring and thus resembling structures in walls of *C. diomedæ*, *elongata*, and *Dictyocysta duplex*.

Nine loricæ: L., total, 80–89 (94.3); collar, 17–20 (18); aboral horn, 16–23 (20.2). D., oral, 40–45 (42.3); neck, 33–38 (35.4); bowl, 46–52 (48.2)μ.

At 20 stations, viz., at 1, 1, 1, and 17, respectively, in Peruvian and South Equatorial currents, Galapagos Eddy, and Drift; at 68–81 (74.8)°; 34 loricæ.

Codonella apicata Kofoid and Campbell

Lorica quite small, acorn-shaped, with rounded turban-like collar, and subglobular, aborally pointed bowl; 1.51–1.81 (1.67) o.d., or 1.20–1.48 (1.34) d. bowl. Oral crest low incurved band with or without primary prismatic structure, with entire or slightly ragged margin. Collar convex, sharply set off by subangular V-shaped nuchal constriction, 0.25–0.30 (0.28) t.l., or 0.41–0.52 (0.47) o.d. in length, with convex outline. Nuchal diameter 0.87–1.03 (0.99) o.d. or 0.73–0.83 (0.79) that of bowl. Bowl stout ovoidal, wider anteriorly, 0.70–0.75 (0.72) t.l. or 1.11–1.30 (1.20) o.d., greatest diameter (1.02–1.13 [1.04] o.d.) at 0.37 of its length. Aboral end a broad, inverted, convex cone of 120–130°, in some loricæ faintly cuspidate. Wall with coccoliths of *Umbilicosphæra mirabilis*, *Coccolithophora wallichi*, *Syracosphæra mediterranea*, and occasionally those that give the duplex structure to the wall. Several kinds appear in the same lorica and fill its surface from oral to aboral end, with larger forms in a group about equator. In some loricæ regular polygonal fields of uniform size and regular distribution occur, and all gradations appear from such regular types to less regular ones with large fenestræ on bowl, and secondary fields of various sizes, from about 20 across bowl to twice as many. Wall thin, a trifle thicker in bowl. Large tertiary fields in one layer only, but secondary fields in two. Closing-apparatus tall, conical (75°) with a small circular aperture at the apex 2 μ in diameter when closed; nearly twice as long as wide, with 13 subequal, subtriangular blades. Animal large, filling 0.7 of cavity of bowl when contracted, with 8 small globular macronuclei and 21 membranelles.

Ten loricæ: L., total, 60–74 (68.5); collar, 18–20 (19.2). D., oral, 37–46 (41.1); collar, 43–52 (47.3); neck, 35–42 (40.6); bowl, 46–60 (51.2)μ.

At 48 stations, viz., at 1, 4, 1, 1, 4, 4, and 33, respectively in California, Mexican, Peruvian, and South Equatorial currents, Panamic Area, Easter Island Eddy, and Drift; at 66–84 (75.5)°; 157 loricæ.

Codonella aspera Kofoid and Campbell emended

Plate 1, fig. 20

Petalotricha galea, Hæckel, 1899, pl. 3, fig. 6.

C. galea, partim, K. and C., 1929, p. 60 (for fig. 106 see *C. galea*); Hofker, 1931b, pp. 353–354, fig. 26 (for figs. 27, 28 see *C. galea*).

Lorica elongate, 1.81 o.d. or 1.60 d. bowl, with deep nuchal constriction, elongated ovoidal bowl, and rounded aboral end. Oral margin irregular or entire. Oral crest narrow hyaline. Collar 0.25 t.l., or 0.45 o.d., an inverted segment of a cone of 30°. Nuchal constriction 0.75 o.d. in diameter. Bowl expands evenly into an elongated, ovoidal, or ellipsoidal form with maximum diameter of 1.17 o.d. at 0.53 t.l. from oral rim. Aboral end bluntly protuberant, tapering to the broadly rounded end. Wall with 2–5 layers of prisms, thinner, and less reticulated on collar. A broad equatorial band of 1–3 rows of large, regular fenestræ, 7–12 in a row across one face, on bowl, anterior and posterior to which fields are smaller and more regular. Large irregular blobs of prismatic material adhere to bowl anterior to equator. Closing-apparatus of 12 blades. Animal large, nearly filling whole lorica. One macronucleus 10 by 25μ.

L., total, 85; collar, 21. D., oral, 47; neck, 35; bowl, 55μ.

At Sta. 4571 in California Current; at 71°; 1 lorica.

Codonella brevicollis (Daday) Brandt

Plate 1, fig. 5

Lorica elongate-ovoidal, 1.69–1.83 (1.76) o.d. or 1.24 d. bowl, with rounded aboral end. Collar short, a segment of a cone of 20–25°, 0.08–0.14 t.l. Oral margin entire, irregular, thinning out to a sharp edge. Bowl ovoidal, wider anteriorly, its greatest diameter 1.31–1.50 o.d., at 0.45–0.48 t.l. from oral margin. Diameter at throat 0.90–1.07 o.d. Aboral end evenly rounded, subhemispherical, without point. Wall unevenly fenestrated, with a band of 4–6 rows of fenestræ at equator, 14–16 across one face, with small interfenestral areas. Collar less distinctly fenestrate, with fainter, more uniform areas. Posterior fenestræ faint, smaller, and less regular than those of collar. Wall thickest at equator and thinning to half at margin of collar, and to a minimum at aboral end, with 1–4 layers of polygons.

L., total, 74; collar, 8. D., oral, 41; neck, 40; bowl, 59μ.

At Sta. 4574 in California Current; at 69°; 1 lorica.

Codonella cuspidata Kofoid and Campbell

Plate 1, figs. 17–19, 21

Lorica moderately tall and stout, with scarcely flaring collar, distinctly constricted throat, wide sack-like bowl, and cuspidate aboral end; 1.37–1.50 (1.47) o.d., or 1.31–1.41 (1.35) d. bowl. Oral crest a wide band 0.1–0.2 of collar in length, with denticulate margin with numerous low, rounded, triangular teeth. Collar an inverted cone of 12–25 (19)°, 0.24–0.29 (0.27) t.l., or 0.37–0.43 (0.39) o.d.; subcylindrical in anterior 0.45–0.60, posteriorly a wider cone of 20–35°. Nuchal diameter 0.82–0.90 (0.86) o.d. Bowl very stout, sack-like, subovoidal and baggy below, 0.57–0.63 (0.61) t.l., or 1.00–1.13 (1.07) o.d., expanding evenly to maximum diameter as segment of outwardly convex cone of 23–27°, to greatest diameter, 1.07–1.12 (1.08) o.d., at 0.55–0.71 (0.60) t.l. from oral margin. Aboral end subhemispherical, with well defined, short, stout, blunt conical point of cuspidate type. Wall uniform with small secondary fields, with larger fenestræ irregular in size and distribution in equatorial zone in some loricæ; 33–41 polygonal fields from oral to aboral end of lorica, with smaller ones at each end, those in the middle being 2–3 times as large as terminal ones. Primary structure in oral crest. Coccoliths found are *Coccolithophora pelagica*, *C. wallichi*, *Pontosphæra syracusana*, *Scyphosphæra apsteini*, and Umbilicosphæra. Closing-apparatus conical, of 12–13 triangular blades, each twice as long as wide. Animal large, nearly filling bowl.

Ten loricæ: L., total, 82–92 (87.5); collar, 22–26 (23.7). D., oral, 56–62 (59.7); neck, 48–56 (51.2); bowl, 62–70 (64.9) μ.

At 32 stations, viz., at 2, 6, 5, 1, 1, 5, and 12, respectively, in California, Mexican, Peruvian, South Equatorial, and Equatorial Counter currents, Panamic Area, and Drift; at 68–84 (77.9)°; 62 loricæ.

Codonella diomedæ Kofoid and Campbell

Plate 1, figs. 11, 12, 13, 14

Lorica very large, elongated and vase-like, with well defined nuchal constriction, broadly elongated sack-like bowl, and flattened aboral end, 1.75–2.22 (2.04) o.d., or 1.57–1.70 (1.58) d. bowl. Oral crest a very low, inturned band. Oral margin irregularly denticulate. Collar turban-like, 0.26–0.30 (0.28) t.l. or 0.45–0.65 (0.55) o.d., expanding evenly from oral margin to greatest diameter, 1.03–1.28 (1.18) o.d., at 0.42 length from oral margin, contracting below as a convex inverted cone of 22–35°. Nuchal diameter 0.95–1.00 (0.96) o.d., or 0.75–

0.86 d. bowl. Bowl elongated, sack-like, posteriorly flattened, 0.70–0.74 (0.72) t.l., or 1.42–1.64 o.d., expanding from throat at angle of 22°, decreasing to 18°, from vertical axis posteriorly to greatest diameter, 1.22–1.42 (1.33) o.d., at 0.56 t.l. below oral margin. Below equator bowl is slightly elongated hemisphere. Aboral end flattened for 0.48 o.d. or less. Wall of secondary polygonal fields of uniform size, 35 across bowl at widest part, and 56 from oral to aboral end. Secondary fields of primary prisms bounded by double-contoured lines, 2–3 times as large in middle of bowl as near oral margin and at aboral end. Fields in some loricæ less regular in size, with larger ones up to twice the typical diameter sparingly interspersed among smaller ones. Wall thickest at nuchal region. Animal filled 0.4 of bowl.

Seven loricæ: L., total, 109–127 (117.7); collar, 27–38 (32.4). D., oral, 55–62 (56.6); neck, 56–71 (59.3); bowl, 72–82 (75.6)μ.

At 6 stations, viz., at 3, 1, and 2, respectively, in Easter Island and Galapagos eddies, and Drift; at 68–79 (72.6)°; 10 loricæ.

Codonella elongata Kofoid and Campbell

Plate 1, fig. 16

Lorica elongate, acorn-shaped, 1.70–1.77 (1.73) o.d. or 1.48–1.61 d. bowl, with tall funnel-shaped collar and elongated ovoidal bowl without aboral point. Oral crest a low band with entire margin. Collar a funnel of 32–40°, 0.22–0.25 t.l., or 0.42–0.53 o.d., with straight, bulging, or sigmoid outline. Nuchal diamater 0.76–0.82 o.d. Bowl ovoidal, wider anteriorly, its greatest diameter 1.04–1.10 o.d., or 0.77–0.89 its length, located midway of lorica; length 0.75–0.88 t.l. Aboral end contracted to less than hemisphere. No aboral point. Wall of oral crest made up of fine primary prisms; of collar faintly reticulated with irregular secondary and tertiary prisms within which primary prisms are visible. Tertiary fenestræ of collar and bowl uniform throughout, 25–40 across widest part of bowl, 35–70 from aboral to oral end, smaller toward aboral end and throat, in some loricæ less regular, always largest on middle of bowl. Intervening meshwork filled with finer secondary prisms and these in turn, especially in collar region, show primary prismatic structure. Wall with 2–3 layers of secondary and tertiary structures, thinning suborally uniformly, and toward aboral end to less than a third that of bowl.

Three loricæ: L., total, 85–87; collar, 21–26. D., oral, 49–50; neck, 38–40; bowl, 52–55μ.

At 3 stations, viz., at 2 and 1, respectively, in California and Peruvian currents; at 68–83 (73.3)°; 3 loricæ.

Codonella galea Hæckel emended

Plate 1, fig. 22; Plate 2, fig. 9

Non *Petalotricha galea* Hæckel, Hæckel, 1899, pl. 3, fig. 6 (see *Codonella aspera*).
Cyttarocylis galea, Gräf, 1909, p. 141.
Codonella galea, partim, K. and C., 1929, p. 60, fig. 106 (see also *C. aspera*); Hofker, 1931b, pp. 352–354, figs. 27–28 (for fig. 26 see *C. aspera*).

Lorica large, stout, with well defined, funnel-like collar, stout, ovoidal bowl, and hemispherical aboral end; 1.39–1.83 (1.53) o.d., or 1.36–1.64 (1.44) d. bowl. Oral crest low, band-like, erect, hyaline, or prismatic, with ragged, or minutely serrate edge, with numerous low, erect, blunt, triangular teeth. Collar an inverted cone of 28–35°, 0.36–0.43 (0.38) t.l. or 0.38–0.50 (0.40) o.d.; with straight or flat sigmoid lateral outline. Neck 0.73–0.95 (0.79) o.d. in diameter. Bowl ovoidal, 0.69–0.78 (0.74) t.l., or 1.03–1.33 (1.13) o.d., expanding evenly as a segment of a convex cone of 30–35° to its greatest diameter, 1.00–1.07 (1.06) o.d., at 0.55–0.59 t.l. below oral margin; length exceeds greatest diameter by 0.1. No aboral point, but at Sta. 4583 a few loricæ had a trace of a central point. Wall with regular, polygonal secondary fields, as at Sta. 4681, 4711, 30–40 on one face, extending from oral crest to aboral end. Mesh made up of smaller areas and enclosures of primary prisms. Coccoliths less in evidence than in *cuspidata* and *acuta*. One lorica at Sta. 4666 (in the area of distribution of *acuta*) is similarly loaded with a broad equatorial zone of *Umbilicosphæra mirabilis*, while collar and aboral regions are filled completely and exclusively with *Syracosphæra mediterranea*. Elongated structures resembling handles of the coccoliths of *Rhabdosphæra claviger* occurred in loricæ at Sta. 4583. Wall 0.04 o.d. in thickness. Large secondary areas 1–2 layers.

Fifteen loricæ: L., total, 92–110 (97.9); collar, 22–30 (25.7). D., oral, 56–69 (64.1); neck, 46–55 (51.2); bowl, 56–74 (68.2) μ.

In our *Conspectus* (1929) we wrongly included in the synonymy of *Codonella galea* a reference to Hæckel's (1899) "Kunstformen der Natur" (pl. 3, fig. 6) listed by that author as *Petalotricha galea* (Hæckel). This figure is obviously a copy of the specimen figured by Entz, Sr. (1885b, pl. 14, fig. 14), though not acknowledged. Since the latter figure is obviously one of *Cod. aspera*, we therefore exclude Hæckel's figure from *Cod. galea*, and emend both species. Gräf's (1909) *Cyttarocylis galea* is probably a *lapsus* for Codonella.

At 22 stations, viz., at 2, 2, 11, 1, and 6, respectively, in California, Mexican, and Peruvian currents, Easter Island Eddy, and Drift; at 67–83 (73.6)°; 73 loricæ.

Codonella nationalis Brandt

Plate 1, fig. 6

Lorica moderately stout, olla-shaped; 1.41 o.d. or 1.29 d. bowl, with convex collar, globular, laterally compressed bowl, and no aboral point. Oral crest a low, hyaline, narrow, outwardly rounded band with an entire, incurved margin. Collar a bulging, inverted cone of 15°, 0.42 o.d. in length, its maximum diameter 1.04 o.d., and nuchal 0.88 o.d. Bowl subglobular, with slight equatorial compression, maximum diameter (1.17 o.d.) at 0.44 of length of bowl. Aboral end somewhat baggy. Wall made up of large, subequal, tertiary polygonal fields, 24 across middle of bowl and 27 from oral to aboral end, smaller aborally and in 1–3 layers. Wall subuniform in thickness, thickest in sides of bowl and nuchal angle, and thinner in aboral end.

L., total, 76; collar, 22. D., oral, 54; neck, 48; bowl, 60μ.

At Sta. 4681 in Drift; at 68°; 1 lorica.

Codonella pacifica Kofoid and Campbell

Plate 1, figs. 3, 10, 15

Lorica sack-like, vase-shaped, 1.68–1.72 (1.70) o.d. or 1.42 d. bowl, with suberect collar, slight nuchal constriction, and no aboral point. Oral margin erect, irregularly wavy. Collar tall, subcylindrical (3°) or funnel-like (15°); length 0.28–0.31 t.l., or 1.72–2.62 o.d. Neck without marked external constriction or internal shelf. Nuchal diameter 0.91–1.00 o.d. Bowl saccular and abruptly expanded for 0.11–0.18 total length as a short segment of a cone of 30–40°, with flat or moderately rounded sides. Maximum diameter 1.18–1.21 o.d. at base of cone. This width continues for 0.3 length of bowl, contracting evenly 25–30° from vertical axis to broadly rounded or squarish aboral end. Wall with 1–3 layers of prisms, of uniform secondary polygonal fields, 30 across bowl and 40 from oral rim to aboral end. Wall thin, thicker laterally. Closing-apparatus with 10 blades, a truncate, concave-sided cone of 50°, 2.33 as wide as tall, with its base at neck. Animal occupies 0.6 of cavity.

Two loricae: L., total, 81–100; collar, 22–28. D., oral, 48–58; neck, 45–59; bowl, 57–70μ.

At 2 stations, viz., 1 each in California Current and Drift; at 69–72°; 2 loricae.

Codonella perforata Entz, Sr., emended Brandt emended Kofoid and Campbell

Lorica elongated, large, and stout, with angled collar, deep nuchal groove, and subspheroidal or ellipsoidal bowl; 1.73 o.d., or 1.38 d. bowl. Collar outwardly angled, divided into suboral and nuchal cones, 0.37 t.l. Suboral crest a low, erect, hyaline band. Oral margin entire. Suboral cone 0.14 o.d., forming an inverted segment of 40° with flat sides. Nuchal cone a trifle shorter than the suboral in Entz, Sr.'s (1884) figure, and about three times as long in ours, forming a segment of 35° with flat sides. Junction of the two cones evenly rounded, or angled as in Entz, Sr.'s lorica. Diameter at angle 1.13 o.d. Nuchal diameter 0.88 o.d. Constriction deeply marked. Bowl subspheroidal or ellipsoidal, its length equal to equatorial transdiameter, or 1.13 o.d. Aboral end hemispherical without point. Wall of irregular polygonal secondary fields, 25–36 across equator, and 37 from oral rim to aboral end. No tertiary fields. Animal has 18 small rounded tentaculoids, 18 membranelles, and 8 or 16 small, scattered, oval macronuclei (Brandt, 1907, p. 19).

L., total, 80; collar, 28. D., oral, 46; collar, 53; nuchal, 42; bowl, 58μ.

At Sta. 4699 and 4703 in Easter Island Eddy and Drift, respectively; at 75°; 3 loricæ.

Codonella rapa Kofoid and Campbell

Plate 1, fig. 9

Lorica stout acorn-shaped, with flaring collar becoming erect orally, well marked nuchal shelf, broadly ovoidal bowl, and stout, blunt aboral horn, 1.92 o.d. Oral margin entire, with slightly thickened, somewhat inturned edge. Oral crest a rather wide hyaline band. Collar an inverted cone of 28°, 0.19 t.l., or 0.36 o.d. Diameter across middle 1.05 o.d., nearly cylindrical in anterior 0.66, definitely convex below. Nuchal diameter 0.91 o.d. Nuchal aperture 0.64 o.d. Bowl broadly ovoidal, rather stout, wider posteriorly; length 0.81 t.l., or i. o.d., expanding regularly from neck at angle of 19° from vertical in

anterior half, with evenly convex sides, to greatest diameter, 1.14 o.d., at equator, and contracting to less than a hemisphere aborally. Aboral horn a stout, broad, bluntly pointed cone of 39°. Basal diameter 0.62 length. Wall of small, subregular, secondary polygons, 25 across bowl and 37 from oral to aboral end. Toward aboral end polygons 0.5 size of those of middle. Wall thinner in collar and posterior half of bowl, with 1–4 layers of polygons. Nuchal shelf 0.18 o.d. in thickness. Lumen of bowl enters aboral horn for half its length, to septum, below which it continues to closed tip.

L., total, 96; collar, 18; horn, 18. D., oral, 50; neck, 42; bowl, 57μ.

At Sta. 4587 in Mexican Current; at 82°; 2 loricæ.

Codonella tropica Kofoid and Campbell

Plate 2, figs. 3, 15

Lorica small, with suberect collar, stout subovoidal bowl, and slightly pointed aboral end; 1.33–1.55 (1.46) o.d., or 1.13–1.26 d. bowl. Collar set off by shallow, acutely notched constriction, subcylindrical in anterior 0.5, more convex aborally. Oral rim denticulate. Suboral crest a low, hyaline, barely inturned band less than 0.1 o.d. wide. Height of collar 0.19–0.25 t.l., or 0.31–0.42 o.d. Nuchal diameter about equal to oral. Collar inverted segment of cone of 18–25° with outwardly convex sides. Nuchal diameter 0.94–1.06 o.d. Bowl spheroidal, subconical aborally, pointed, length 1.20–1.23 (1.21) o.d., about equal to greatest diameter at 0.54–0.61 t.l. from oral end, contracting in an almost hemispherical contour to aboral point as a short convex cone of 125°. Wall thin, of rounded, elliptical, polygonal, or sometimes even hexagonal, secondary fields with double-contoured mesh, with primary prisms in fields, 32 across one face, and 42 from oral rim to aboral point. Closing-apparatus, when retracted, a low cone below collar, with 12–13 subequal blades.

Four loricæ: L., total, 70–77; collar, 12–20. D., oral, 45–57; neck, 46–55; bowl, 60–65μ.

At Sta. 4594 in Mexican Current and 4638 in Panamic Area; at 75–84 (79.5)°; 25 loricæ.

3. CODONARIA gen. nov.

Codenella, *partim*, K. and C., 1929, pp. 51–52 (see also Codonella).

Codonellidæ with short pot-shaped lorica, divided externally into collar and bowl; collar never annulated nor spiral, never distinct in wall structure from bowl, never longer than bowl, and always with suboral cone superposed above collar proper; aboral end rounded or pointed, never with aboral horn; wall with fenestrated regions and frequently with coccoliths; closing-apparatus with up to 24 blades near equator of bowl; marine, eupelagic in warm temperate and tropical seas. Type species *Codonaria cistellula* (Fol, 1884), a common and the oldest species, of genus, from off Villefranche-sur-Mer.

Close to Codonella in all respects except suboral cone. Suboral crest on rim of suboral cone occurs also in a few species of Codonella. Suboral ledge, the morphological equivalent of the oral aperture of Codonella, flares more and has a thickened rim, not found in Codonella. Nuchal constriction better developed and lacks internal nuchal shelf.

Contains eight species, of which 6 occur in Expedition material. Of the 8, 6 are new, 4 of which are in the Expedition material. Subdivided into 2 series: — the *angusta* series, including *angusta, australis, oceanica, lata,* and *benguelensis;* and the *dadayi* series, including *dadayi, muronata,* and *cistellula.*

Codonaria australis (Kofoid and Campbell)

Plate 2, fig. 13; Plate 3, fig. 12

Lorica small, moderately stout, top-heavy; 1.48–1.66 (1.58) o.d., or 1.28–1.44 (1.34) d. bowl. Suboral crest narrow, subconical (35°), 0.18 suboral cone. Oral margin entire or minutely and irregularly denticulate. Suboral cone a tall segment of a cone (44–55°) outwardly straight or slightly convex, with base 1.08 o.d., and length 0.16 o.d. Suboral trough (90°) deep, narrow, and V-shaped. Suboral ledge formed in some loricæ by distal margin of collar, lacking flare of its own; in other loricæ a short segment of an outwardly convex cone (25°) 0.07–0.14 o.d. in length. Diameter of ledge 1.20–1.38 (1.28) o.d., its margin entire or irregular. Collar a tall inverted segment of a cone (25–35°) 0.31–0.35 (0.34) t.l., or 0.32–0.51 (0.44) o.d., with straight or outwardly convex sides. Neck deeply and acutely constricted to 0.82–0.97 (0.87) o.d. or 0.71–0.79 (0.75) d. bowl. Bowl subspheroidal, slightly elongated, with faint aboral point in some loricæ, length 0.64–

0.69 (0.65) t.l., 1.00–1.06 (1.04) o.d. or 1.08–1.21 (1.13) its transdiameter. Aboral end slightly, but never acutely, pointed (140°), often simply rounded. Wall thicker in ledge, and thickest at throat, 0.1 o.d. Two layers of regular, subuniform secondary polygons in suboral cone, and 3 elsewhere. Large subcircular tertiary areas on middle and lower region of bowl, 3–4 times as large as secondary polygons. Forty secondary fields across bowl and 22–46 from oral to aboral end. Primary prisms in suboral crest and secondary prisms of collar and bowl. Wall with variety of patterns based on combinations of two structures, secondary polygons rather uniform in size and subregular in outline, and larger subcircular tertiary fields, often containing coccoliths. Loricæ from stations in Perubian Current often have "duplex" character. At Sta. 4734 encrusted with *Rhabdosphæra claviger*, with handles projecting, *Coccolithophora leptopora* in wall, and *Pontosphæra syracusana* in collar and bowl. Elongated rhabdoliths are unusual in loricæ. Animal large, with 24 membranelles and wide conical (110°) closing-apparatus of wrinkled folds in upper half of bowl.

Ten loricæ: L., total, 74–78 (76.4); collar and cone, 24–28 (26.5). D., oral, 46–51 (48.2); ledge, 60–65 (61.9); neck, 41–44 (42.2); bowl, 54–61 (56.9)μ.

At 15 stations, viz., at 3, 1, 2, and 9, respectively, in Mexican and South Equatorial currents, Panamic Area, and Drift; at 68–84 (78.2)°; 37 loricæ.

Codonaria benguelensis (Kofoid and Campbell)

Lorica moderately tall, stout, with narrow suboral cone, wide collar, and spheroidal bowl, 1.56 o.d. or 1.42 d. bowl. Suboral crest wide, suberect, 0.3 of suboral cone. Oral margin ragged, irregular, without denticulations. Suboral cone a low segment of a cone (25–56°), with outwardly concave sides, base 1.03 o.d. in diameter and 0.24 of cone and collar, or 0.12 o.d. in length. Trough deep, broad, V-shaped (65°). Suboral ledge wide, 1.11 o.d., an upturned segment of an inverted cone distally 40°, changing to 120° as it joins collar. Margin irregular, length 0.14 of collar. Collar an inverted segment of a cone (25–29°), 0.30–0.33 t.l. or 0.50–0.65 o.d., with plane or barely convex sides. Neck not deeply constricted, 0.87–1.00 o.d. or 0.80 d. bowl. Bowl spheroidal or slightly ellipsoidal, 0.67 t.l. or 1.12 o.d., expanding evenly 1.19 o.d. near middle. Aboral end without point. Wall thickest at neck. Large secondary areas in single layer, primary alveoli in 3–5 layers. Secondary fields 32 across middle of bowl, and 37 from oral

to aboral end, those of collar more definitely polygonal and half the size of those of equatorial region. Some polygons of bowl ovoidal in outline, in 9–11 rows, with duplex tertiary fenestration near equator, recalling some other Codonellidæ and *Dictyocysta duplex*. Secondary polygons of aboral third similar to those of collar. Primary structure inside secondary polygons and in suboral crest. Single row of secondary fields in suboral ledge.

L., total, 88; collar and cone, 27. D., oral, 52; ledge, 64; neck, 50; bowl, 62μ.

At 3 stations, in Drift; at 72–82 (78.3)°; 3 loricæ.

Codonaria cistellula (Fol)

Lorica very large, tall, with wide ledge and acute aboral end; 1.69–2.10 (1.92) o.d., or 1.32–1.40 (1.37) d. bowl. Suboral crest short, suberect, 0.35 suboral cone. Oral margin entire. Suboral cone a very tall segment of a cone (40°), with outwardly straight or slightly concave sides, base 1.04 o.d., length 0.21 cone and collar, or 0.13 o.d. Trough (119°) rather wide, shallow, V-shaped. Suboral ledge a wide, short segment of an outwardly concave inverted cone (85°), equaling, or a little longer than, suboral cone. Ledge 1.28–1.32 (1.29) o.d. Margin entire. Collar an inverted segment of a cone (30–37°), 0.33–0.35 t.l. or 0.57–0.67 o.d., with straight sides. Neck typically deeply, but sometimes not acutely, constricted. Nuchal diameter 0.86–0.95 (0.94) o.d., or 0.64–0.75 (0.67) d. bowl. Bowl elongated subspheroidal to globular, 0.63–0.67 (0.66) t.l., or 1.68–2.10 (1.90) o.d., expanding evenly to greatest diameter (1.29–1.54 [1.47] o.d.) at or near middle. Aboral end with barely emergent, blunt, conical (40°) point. Wall thickest in collar, thinning toward aboral end to less than a fourth, with 2–3 layers of regular secondary polygonal fields, 30–40 across equator and 50–60 from oral to aboral end, with equatorial zone of larger elliptical tertiary fields extending from inner to outer face, 2–3 times as large as secondary fields, freely interspersed among them. Animal with 18 membranelles and 8–16 very small regularly spaced macronuclei (meiotic?), (Brandt, 1907, pp. 19, 97). Closing-apparatus, figured by Entz, Jr. (1908, pl. 1, fig. 14; pl. 10, fig. 10), a cone (40°), with 16 or 18 blades, length 0.45 basal diameter, attached at nuchal level. Entz, Jr. figures 4 narrow spindle-shaped macronuclei, 14 membranelles, and 40 spiral rows of short body cilia.

Seven loricæ: L., total, 91–116 (104.0); collar and cone, 30–39

(35.4). D., oral, 49–58 (54.7); ledge, 65–75 (70.9); neck, 49–52 (51.3); bowl, 68–81 (76.0)μ.

At 5 stations, viz., at 2, 1, aud 2, respectively, in California, Mexican, and Peruvian currents; at 68–83 (75.6)°; 5 loricæ.

Codonaria lata Kofoid and Campbell

Plate 3, fig. 7

Lorica moderately large and very stout; 1.47–1.81 (1.64) o.d., or 1.25–1.40 (1.30) d. bowl. Suboral crest wide, suberect, 0.3 of suboral cone. Oral margin irregularly and abundantly denticulate with small, subuniform, equidistant, erect or curved teeth. Suboral cone a short segment of a cone (38–50°) with outwardly straight or even deeply concave sides, with base 1.06 o.d. and length 0.23 of cone and collar, or 0.1 o.d. Suboral trough shallow, narrow, formed by the outwardly rounded, widely flaring horizontal ledge projecting from distal margin of conical collar, contracting (150°) inwardly toward trough. Diameter of ledge 1.11–1.36 (1.22) o.d. Margin with many irregular, unequal, hardly equidistant, blunt denticulations. Collar a tall inverted segment of a cone (36–50°), 0.29–0.36 (0.33) t.l., or 0.47–0.61 (0.55) o.d., with sides outwardly convex. Neck slightly constricted to 0.83–0.96 (0.91) o.d., or 0.71–0.85 (0.79) d. bowl. Bowl subglobular, aborally flattened, 0.64–0.71 (0.67) t.l., 1.03–1.20 (1.11) o.d., or 0.84–0.97 (0.88) transdiameter; expanding evenly from neck to greatest diameter, 1.15–1.40 (1.26) o.d., at 0.55–0.60 its length. No aboral point. Wall of subregular polygonal secondary fields, 25–30 across equator and 34–40 from oral to aboral end, smaller on suboral cone and aboral end than on bowl. Primary structure alone on suboral crest. Boundaries of secondary areas formed by trabeculæ consisting of primary prisms, fainter within areas enclosed by trabeculæ. Closing-apparatus truncated, conical (50°), with 10 blades. Animal large, filling over 0.5 of lorica.

Ten loricæ: L., total, 78–90 (85.9); collar and cone, 24–32 (28.5). D., oral, 47–58 (52.2); ledge, 59–68 (63.6); neck, 44–50 (47.4); bowl, 57–68 (65.6)μ.

At 19 stations, viz., at 1, 2, 5, and 11, respectively, in California and Peruvian currents, Easter Island Eddy, and Drift; at 68–83 (77.7)°; 170 loricæ.

Codonaria mucronata Kofoid and Campbell

Plate 2, figs. 6, 16

Lorica short, stout, and baggy; 1.48–1.60 (1.54) o.d., or 1.26–1.38 (1.31) d. bowl. Suboral crest wide, 0.3 of suboral cone. Oral margin entire, irregular, or minutely serrate. Suboral cone a segment of a cone (35–60°), with straight or outwardly concave sides and base 1.05–1.13 o.d., length 0.11–0.23 of cone and collar, or 0.08–0.10 o.d. Suboral trough deep and wide (90°). Suboral ledge stout, wide, not a continuation of the flaring collar, but dropping toward horizontal, forming a well defined shelf; a short segment of an outwardly convex cone (115°); length 0.5–0.8 suboral cone or 0.1 o.d. Ledge 1.26–1.38 (1.32) o.d. Margin entire, or irregular with numerous bluntly angled projections. Collar tall, a wide inverted cone (30–45°), with bulging sides, 0.27–0.37 (0.34) t.l., or 0.45–0.57 (0.51) o.d. Neck moderately constricted, 0.83–0.94 (0.91) o.d. or 0.63–0.72 (0.68) d. bowl. Bowl broadly obovate or rotund, inflated posteriorly, with aboral point, 0.59–0.69 (0.63) t.l., 1.07–1.26 (1.11) o.d., or 0.79–0.89 (0.85) transdiameter; expanding evenly to greatest diameter, 1.29–1.37 (1.34) o.d., contracting below within contour of sphere, with resulting baggy outline. Aboral end with regular, bluntly rounded, slightly emergent aboral point, conical (65°), not exceeding 0.08 o.d. Wall of fairly regular secondary polygons, 25–30 across equator, 37–40 from oral to aboral end. Trabeculae of prominent primary prisms. Fainter prisms in enclosed fields. Tertiary areas of rounded, elliptical, or subpolygonal form, twice or three times as large as secondary fields, interspersed in equatorial zone in one or more irregular lines and on collar. Tertiaries entirely lacking in many loricae, but in others filling up to a third of surface. Coccoliths of *Coccolithophora pelagica* in such areas in a few loricæ. At Sta. 4681 this species, with *Dictyocysta duplex*, *Codonella diomedæ*, and *C. elongata*, has circular "duplex" structures on most of surface of bowl. Closing-apparatus low, conical, of 10–13 blades. Animal fills over 0.5 cavity.

Ten loricæ: L., total, 78–87 (84.5); collar and cone, 26–32 (29.4). D., oral, 46–50 (48.0); ledge, 60–67 (63.2); neck, 40–46 (43.8); bowl, 61–69 (64.2) μ.

At 37 stations, viz., at 2, 1, 12, 1, 2, and 19, respectively, in California, Mexican, Peruvian, and South Equatorial currents, Galapagos Eddy, and Drift; at 66–84 (72.8)°; 99 loricæ.

Codonaria oceanica (Brandt emended)

Codonella cistellula var. *a oceanica, partim*, Brandt, 1907, pp. 80, 98, 459.
C. cistellula var. *a* Brandt, 1907, p. 86.
C. cistellula var. *oceanica* Brandt, 1907, pp. 99, 474.

Lorica short, stout, with widely flaring collar and globose bowl; 1.61–1.75 (1.69) o.d., or 1.27–1.40 (1.30) d. bowl. Suboral crest erect or narrow subconical (60°), 0.25 of suboral cone in length, not differentiated in some loricæ. Oral margin entire or irregularly and coarsely toothed. Suboral cone (80–93°) a low, wide segment with outwardly concave or straight sides, with base 1.20 o.d., and length 0.16 of cone and collar, or 0.1 o.d. Trough feebly developed; instead, cone and collar form a wide angle (111°). Suboral ledge moderately wide, 1.23 o.d. in diameter, upwardly and outwardly directed with irregular margin, or a narrow horizontal flange, with regular margin, or forming widened base of inverted, conical collar. Collar an inverted segment of a cone (40–47°) 0.32–0.36 t.l., or 0.54–0.58 o.d., with straight or outwardly convex sides. Neck deeply constricted. Nuchal diameter 0.82–0.92 o.d. or 0.68–0.77 d. bowl. Bowl globose, 0.66–0.68 t.l. or 1.06–1.19 o.d., expanding evenly from neck to greatest diameter, 1.18–1.29 o.d., at 0.57–0.62 t.l. from oral margin, or 0.48 length of bowl from neck. Aboral region hemispherical. Wall thickest in neck and bowl, two-thirds as thick in collar, thinning down to less than a third at aboral end; of uniform regular secondary polygonal fields, 20–25 across bowl and 32 from oral to aboral end. No tertiary structure.

Four loricæ: L., total, 70–82 (75.0); collar and cone, 22–28 (25.5). D., oral, 40–48 (47.0); neck, 37–44 (40.7); bowl, 50–62 (57.7) μ.

At 4 stations, viz., at 1, 1, and 2, respectively, in Panamic Area, Easter Island Eddy, and Drift; at 72–80 (75.5)°; 9 loricæ.

4. CODONOPSIS gen. nov.

Cyttarocylis, *partim*, K. and C., 1929, p. 115, fig. 212 (see also Cyttarocylis).

Codonellidæ with stout pot-shaped lorica. Suboral cone short, truncated conical. Suboral shelf horizontal. No nuchal constriction. Aboral end broadly rounded. Wall with thin outer and thick inner lamina and strongly developed secondary prismatic middle layer with fine primary prisms. No agglomerated particles on wall. Eupelagic in tropical seas. The type and only species is *Codonopsis ollula* (Brandt),

described from off Sunday Island in the Tropical Pacific by Brandt (1906, p. 22, pl. 36, fig. 10; 1907, pp. 200–201).

Codonopsis is wholly different from Cyttarocylis, in which genus Brandt (1906, 1907) placed it, in the fundamental characteristics of the structure of wall and suboral pattern. The general form of the lorica is also much more like that in Codonella and Codonaria than in Cyttarocylis. Specifically, the wall of Cyttarocylis has a coarse, regular, polygonal reticulum on the surface, while the wall of Codonopsis, Codonella, and Codonaria is smooth. Furthermore, the pattern of the secondary polygons of the intermediate layer in the wall of Codonopsis is similar to that of the Codonellidæ and unlike that of Cyttarocylis. The suboral structure of Codonopsis consists of a suboral cone and ledge, homologous to that of Codonaria, while that of Cyttarocylis is a flaring collar above a nuchal constriction, a structure absent in Codonopsis.

Codonopsis ollula (Brandt)

Lorica small, very stout, rotund, with conical collar, stout, horizontal, suboral shelf, no nuchal constriction, no internal nuchal shelf, broadly ovoidal bowl, and subhemispherical aboral end; 1.57–1.65 (1.60) o.d. Oral margin entire. Oral diameter 0.61–0.64 (0.63) t.l., 0.71–0.75 (0.73) length of bowl, or 0.77–0.81 (0.79) d. suboral shelf. Collar a low cone (38–56°), 0.14–0.16 (0.15) t.l., or 0.22–0.25 (0.24) o.d., with sides outwardly straight or concave, with deepest portion submedian, increasing regularly to posterior end (1.08–1.13 o.d.). Suboral shelf a heavy ring, thick, horizontal, homologous to flaring shelf in Codonaria and to funnel-shaped collar of Cyttarocylis; diameter 1.24–1.29 (1.25) o.d.; width 0.09–0.12 o.d.; varying from subangular (16°) flat shelf to a low rounded ridge with upper surface slightly concave and outer edge angular (86°) to semi-circular in section. Bowl rotund, short, 0.84–0.86 (0.85) t.l. or 1.33–1.40 (1.36) o.d., broadly ovoidal, its greatest diameter, 1.33–1.42 (1.37) o.d., located at 0.50–0.55 t.l. below oral margin. Aboral end subhemispherical to faintly subconical (90°), well filled out, and in some loricæ with a tendency to aboral flattening similar to, but not so evident as that in *Cyttarocylis eucecryphalus*. Wall with a well defined, uniform secondary polygonal meshwork of hexagonal pattern with angles not rounded and narrow raised marginal beams. Polygons of two sizes on collar; smaller ones less than half the size of others, in an upper suboral band of nearly half width of collar, and larger in lower part. Small prisms around

oral margin, 70 across one face in 3–7 rows. Larger prisms across middle of collar, 47–52 in 4–6 rows. Suboral shelf with 3–4 rows, two deep. Secondary polygons 36–40 across upper end of bowl, 50–70 on equator and from end to end, in a single layer except in nuchal ledge, appearing in section as subuniform, subequal rectangles with longer axes perpendicular to surface, with double-contoured walls enclosed between uniformly thin outer and thicker inner hyaline laminæ. Secondary prisms enclose 10–18 subhexagonal primary prisms in 6–8 layers. Wall in collar half as thick as in bowl, and one-fourth of that in nuchal shelf.

Four loricæ: L., total, 83–90 (88.0); collar, 12–14 (13.0); bowl, 71–77 (75.4). D., oral, 53–58 (55.0); ledge, 66–73 (69.5); bowl, 72–78 (75.6) μ.

At 21 stations, viz., at 1, 5, and 13, respectively, in Peruvian Current, Easter Island Eddy, and Drift; at 68–75 (71.7)°; 50 loricæ.

III. CODONELLOPSIDÆ Kofoid and Campbell emended

Codonellopsidæ, *partim*, K. and C., 1929, p. 67 (see also Dictyocystidæ for Luminella.

Tintinnoinea with top-shaped lorica with hyaline cylindrical collar and denser rotund bowl; oral rim entire or very rarely toothed; collar with spiral or annular structure; bowl patterned, generally short, globular or top-shaped; aboral end closed (except in Laackmanniella), rounded, pointed, or with an aboral horn, with central canal sometimes open distally, or closed off by a septum; wall of collar hyaline with primary structure only, not patterned, except for fenestræ; wall of bowl with coarse secondary structure, or with superposed tertiary; 2–8 macronuclei; 18–20 membranelles; entirely marine and usually oceanic.

As founded by Kofoid and Campbell (1929) it includes Stenosemella with 7 species, Codonellopsis, 39, and Laackmanniella, 2. Only the first two are represented in our collections, Laackmanniella being Antarctic in distribution. The most primitive is Stenosemella, distinctly allied with Tintinnopsis in having a heavy, blob-bearing bowl of rounded form, and in lacking distinct laminæ on the inner and outer surfaces of the bowl, but differing from it in having a low, hyaline, sometimes spiral collar narrower than the bowl, a character which allies it with Codonellopsis.

The type genus, Codonellopsis, has a very long hyaline collar with many distinct spiral turns, and a dense-walled bowl, in which it resembles Stenosemella. In a few species, such as *Cdps. tuberculata*, the

collar is very low, with hardly more than one or two turns of the spiral, but in the majority of species the collar is as long as, or longer than, the bowl. The aboral end in the majority of species is rounded, and in the remainder has an aboral horn. Laackmanniella resembles Codonellopsis in having a long, hyaline annular or spiral collar and a denser bowl, which, however, is no wider than the collar. Unlike either Stenosemella or Codonellopsis, it has its aboral end widely open. This character is a generic one in Leprotintinnus (Tintinnididæ) and a subfamily one in the Salpingellinæ, which are widely separated from Laackmanniella taxonomically. *Cdps. tuberculata* forms a transition between the two genera Codonellopsis and Stenosemella. This species, however, would seem to belong to Codonellopsis rather than to Stenosemella, since the bowl is intermediate in its finer structure and resembles somewhat that of *Cdps. cordata* in this regard. *Cdps. cordata* has a collar which undoubtedly allies it with Codonellopsis. The collar of *tuberculata* is much like that of Stenosemella, being hyaline and made up of one or two low rings or spirals. The connecting links between Codonellopsis and Laackmanniella are of a more general nature, although no less obvious. One genus of the Dictyocystidæ, Luminella, which includes species formerly assigned to Stenosemella in our *Conspectus*, is characterized by having the collar provided with semilunar windows homologous with the larger ones of Dictyocysta.

Stenosemella is more or less neritic in coastal waters. Codonellopsis is structurally more advanced, eupelagic, and attains its maximum speciation in tropical waters. Laackmanniella is also structurally advanced and eupelagic, but is confined to Antarctic waters.

5. STENOSEMELLA Jörgensen

Stenosemella, *partim*, K. and C., 1929, pp. 67–68 (see also Luminella).

Codonellopsidæ with short, wide, olive-shaped lorica; never with spiral structure in bowl; oral aperature always narrower than bowl; oral margin entire; collar less than 0.3 o.d. in length, sometimes with 1–2 spiral turns, hyaline, thin, and usually free from adherent particles, *never* with windows; bowl usually with shoulder, widest at or above middle; no aboral horn; wall firm and dense, covered with agglomerated particles or with a coarse irregular reticulum; marine, neritic in temperate and northern waters. Type species *Stenosemella ventricosa* (Claparède and Lachmann, 1858, pl. 9, fig. 4) Jörgensen (1924, pp. 95, 96, fig. 107) from North Sea off coast of Norway.

Established by Jörgensen (1924, p. 95) for three species, *ventricosa* (Clap. and Lach.), *steini* (Jörg.), and *nucula* (Fol). In 1929, in our *Conspectus*, we added *avellana*, *nivalis*, *oliva*, and *producta* from Meunier (1910), who had included them in Tintinnopsis, and *S. expansa* and *punctata* from the same genus, described by Wailes (1925), renamed Wailes's *Tps. punctata* forma *minor* as *S. pacifica*, and described one new species, *S. inflata*, based on one of Wailes's (1925) figures of *Tps. punctata*.

In this Report we transfer from Stenosemella to a new genus Luminella (Dictyocystidæ) three species, *S. pacifica*, *inflata*, and *punctata*, with semilunar windows in the collar.

Of the seven species of Stenosemella only one, *nivalis*, occurs in Expedition material. None of the seven is new; all are well known from neritic European waters.

Related to Codonellopsis in having a dense bowl and hyaline collar, but differing in having a short, ring-like collar of one or two turns, instead of a tall one with many turns. *Codonellopsis tuberculata* resembles Stenosemella in its low collar, but the bowl is not so dense and lacks the surface agglomerations and reticulum.

The species remaining in the genus are *avellana, oliva, nivalis, producta, expansa, steini*, and *ventricosa*.

Stenosemella nivalis (Meunier) emended Kofoid and Campbell

Plate 3, fig. 3

Tintinnopsis nuclela, Kofoid and Swezy, 1921, p. 261 (*lapsus pennæ* for *Tps. nucula* Lohmann, 1908, pp. 296–297 = *S. nivalis*).

Tps. nucula, Hofker, 1922, pp. 170–171, fig. 79 (a, b).

S. nucula, Hofker, 1931b, pp. 362–364, figs. 40–42 (see also *Tps. nucula* and *S. oliva*).

Lorica small, with low collar. Bowl widest across anterior third, contracting posteriorly, aboral end rounded, 2.00–2.31 (2.13) o.d. Collar very low, 0.06 t.l., 0.42 d. bowl at top, forming segment of cone (24–40°), hyaline, thin-walled, lacking half-moon-shaped windows of Luminella. Collar wholly lacking in some loricæ, or incrusted with adherent matter. Oral margin entire. Bowl ovoidal, truncated at oral end, widest (1.84–2.50 [2.06] o.d.) at 0.4 t.l. Length 1.2 its greatest diameter. Aboral end rounded. Wall irregular in thickness; very thin in collar, with small primary prisms; thicker in bowl, especially toward aboral end, with 2–5 layers of large pentagonal polygons, 17–22 across bowl, and 13–22 from oral to aboral end. Animal with 2 bean-shaped

macronuclei, 2 globular micronuclei, and 22–24 membranelles. Frequently found in the faeces of sardines and copepods, and in food vacuoles of tintinnids.

Five specimens: L., total, 35–67; collar, 10–20. D., oral, 20–25; bowl, 28–55μ.

Groups of six or more loricæ (?) have been found (Sta. 4624) stuck together side by side in an irregular way. The junior author found in San Francisco Bay chains of 3–20 lorica-like structures similar to those of Dixon and Joly (1898, pl. 26, fig. 5). These chains resemble the tests of the foraminiferan *Reophax gracilis* (Kiaer) in size, curved lines of connected shells, and shape and number of constituents. Dixon and Joly assigned them to *Stenosemella nivalis*, but they are not proven to belong to this species, or indeed to the Tintinnoinea.

Hofker (1922, fig. 79a, b) includes in his synonymy two of Brandt's (pl. 16, figs. 12–13) figures, which we (1929, pp. 37, 41) assign to *Tintinnopsis nucula* (pl. 16, fig. 12) and *lata* (pl. 16, fig. 13). Later (1931b, p. 364) he includes in the synonymy of *S. nivalis* two of Meunier's (1910) species, *avellana*, and *oliva*, which we (1929, pp. 69–70) had retained. He designated them as "fehlerhaften Zeichenfeder Meuniers." Until Meunier's two species in Arctic plankton can be reëxamined, they are best retained in their present status.

At 8 stations, viz., at 1, 4, 1, and 2, respectively, in California, Mexican, and South Equatorial currents, and Panamic Area; at 77–84 (81.7)°; 40 loricæ.

6. CODONELLOPSIS Jörgensen

Codonellopsidæ with lorica divided into hyaline, annular or spiral collar and heavy-walled bowl; collar set off distinctively in structure from bowl, always, except in *Codonellopsis glacialis*, narrower than bowl, always with spiral or annular structure, with one to many rings or turns, sometimes longer than bowl; bowl sphaeroidal to ovoidal, or even ellipsoidal, with or without an aboral point or a hollow aboral horn closed off from cavity of bowl by a septum; wall of collar hyaline, with primary structure only; wall of bowl dense with secondary and often tertiary structure, sometimes with fenestræ, more rarely with agglomerated material, and frequently with coccoliths. All pelagic and marine, largely in warm temperate and tropical seas. Type species *Codonellopsis orthoceras* (Hæckel) Jörgensen from off Messina.

Condonellopsis offers indirect evidence regarding the method of formation of the lorica. The fact that many of the species have an

aboral horn of *variable* length in different individuals suggests that it is formed either at the time when the animal is fatigued or when the supply of lorica-forming material has run low. There are also exceptional instances in individual loricae in which this material appears to be present in excess and to have been utilized in prolonging the aboral horn. The presence of a minute canal which sometimes persists, is evidence of the presence of a cytoplasmic connection between two daughter animals at the time of division, and of the fact that this connection between the two is kept up for some time after the anterior daughter has all but separated from the posterior one of the pair. This connection gives time for the posterior daughter to aid, by means of its membranelles, in moulding up at least the aboral region of the anterior lorica. The fact that loricæ of such diverse genera as Codonellopsis, Laackmanniella, Climacocylis, Cyttarocylis, Petalotricha, Rhabdonella, Xystonellopsis, and the whole subfamily Salpingellinae, have either minutely or widely open aboral ends suggests that these divergent genera are formed in much this same way, and no fundamentally different explanations are required to account for their formation. In one of the loricæ of *contracta* (Plate 3, fig. 2) there are annular lines on one side of the bowl, strongly suggesting that this part of the lorica, as well as the spiral collar, is built up by the spiral application of material laid down by the animal at the time of fission. The solid aboral spinule is the homologue of the open aboral pegs of other genera. Such spinules seem to be closed up as the two daughters separate after the protoplasmic connection has been severed but contact persists. In Codonellopsis the lumen of the aboral horn is often closed off by a thin septum, possibly laid down from within after the horn is formed. In most of the genera there are species, or individuals in which spiral or annular lines are present on the bowl. This is neatly seen in *Leprotintinnus nerilicus*, *Tintinnopsis campanula*, *Tps. karajacensis*, as well as in *Cdps. contracta* and *cordata*.

In *ostenfeldi* the lorica is divided into the usual collar and bowl, but the former has two regions, a suboral section 0.1 total length, with two or three annuli, and a cylindrical section below with a length 0.36 total length. The wall of this region has 5–6 leiotropic (25°) rows of 5–6 oval to hexagonal fenestræ, each of which is separated from the others by a surrounding, raised trellis. These facts suggest that an appreciable time is involved in the building up of the two major regions, and that the operation of several internal and external factors is concerned, namely, substance secretion, surface tension, and the coordinated individual activity of both daughters. In his account of

"Die Bildung der Tintinneengehäuse" Hofker (1931a) states (p. 144), ". . . es würden die Hülsen der *Tintinnopsis*-Arten namentlich durch Ausschwitzen einer schnell erhärtenden Substanz auf der Oberfläche entstehen; nachträglich würde dann eine weitere Modellierung statt finden." With this statement the junior author (Campbell, 1926a, 1930) is in agreement save in two fundamental particulars. These are, in the first place, the fact that in the forms examined, i.e., *Stenosemella nivalis*, *Luminella pacifica*, *Favella franciscana*, and *Tintinnopsis reflexa*, the substance extruded is produced not from the surface of the body but through the mouth, and, in the second place, the fact that the shaping up of the lorica occurs primarily during fission, and not later. It was also found (Campbell, 1926a, p. 213) that "from time to time the animal within a lorica may add to its own lorica by its own neuromotor activities." Hofker illustrates this process (1931a, figs. 10–12) in *Tps. campanula*. In his account of *Tps. beroidea* (1931b, pp. 335–336) Hofker also illustrates an animal (fig. 16) with a broad ring of lorica material at the oral end and not over the whole body. This scarcely demonstrates that the lorica is formed by local secretion over the whole body. A later figure (fig. 17d), indeed, shows a dividing pair in which the two daughters are still attached and the beginning of the new lorica is already present about the anterior daughter. Hofker (1931a, fig. 16; 1931b, pp. 368–369, fig. 48) claims that the "circumoral ciliary crown" acts to repair and form the collar, but he is at a loss to account for the formation of the aboral region. He seeks to account for many of the differences between our species, especially in the anterior structures, in forms related to *orthoceras*, as largely due to the individual activities of the membranelles. This ability to repair or add foreign matter to the lorica does not demonstrate that the added material or the manner in which it is deposited has much to do with the fundamental method by which the lorica is laid up. We are by no means certain that the lorica-free ciliates which are sometimes seen in freshly caught plankton are in reality tintinnids or, if they are, that they can or do construct new loricæ. In most instances the inhabitants desert their loricæ on slight provocation. Neither is it certain that the "cysts" found within loricæ are always those of Tintinnoinea.

The loricæ of Codonellopsis are separable into logically definable species, and, in view of our very abundant material, representing a wide geographical area along a route of about 15,000 miles, we believe that these species, often based upon many individuals (in some instances hundreds) carefully studied, are valid. Hence Hofker's (1930) criticism of our *Conspectus* that many of our species are "Formen oder

Aberrationen" is unfounded. His observations have been largely upon local material from the Mediterranean and the North Sea. Further evidence of the validity of these species is attested by the fact that loricæ similar to ours are common in virtually every tropical sea explored. These different groups of loricæ appear to have an actual genetic pattern based on constant behavioristic and secreting differences of the various groups constructing them. Similar facts govern in the other genera of the Tintinnoinea.

In a few species, prominent among which is *Cdps. ostenfeldi*, there are fenestræ in the collar, as in Luminella. These are, however, in several rows and are circular instead of semilunar, and are probably due to some food element. Their circular form and irregular numbers suggest that they may be remnants of coccoliths. Otherwise the two genera have little in common.

Established by Jörgensen (1924) for 5 species which had been previously assigned to Codonella but which differed from the others of that genus in having a hyaline, spiral collar. The genus as described by Jörgensen included *orthoceras* (the type), *morchella*, *lusitanica*, *lagenula*, and *tuberculata*. It was later amplified by Kofoid and Campbell (1929), who added to Jörgensen's species by segregation from his figures and synonymy, and on the basis of material from his *Cdps. morchella* the following: *Cdps. americana*, *erythräensis*, *globosa*, and *indica;* and six from his *Cdps. lagenula: brasiliensis*, *contracta*, *inornata*, *lata*, *pusilla*, and *ornata*. In addition to these, certain varieties of *orthoceras* named or lettered by Brandt (1906, 1907) were by us given specific status, either singly or in combination, although included by Jörgensen (1924) in Brandt's species, as follows: *Cdps. longa*, *minor*, *pacifica*, *parva*, *pura*, *speciosa*, and *tessellata*. Meunier's (1919) *Tintinnopsis bulbulus*, Laackmann's (1907) *Codonella glacialis* later (1909) transferred to Leprotintinnus, Brandt's *Codonella morchella* var. *schabi*, and Entz, Jr.'s (1908, 1909b) *Ptychocylis orthoceras* (as *Cdps. turbinella*), were all allocated to Codonellopsis in specific status because of evident morphological relationships to this genus. In all, 18 new species were described, as follows: *Cdps. americana*, *californiensis*, *contracta*, *cordata*, *globosa*, *indica*, *inflata*, *lata*, *longa*, *meridionalis*, *obconica*, *parva*, *robusta*, *speciosa*, *tropica*, *turbinella*, *turgescens*, and *turgida*. Of these 18 there were 13 based on material from the Expedition.

Contains 39 species, of which 18 are recorded in Expedition material. Subdivided into Codonelloides subgen. nov. and Codonellopsis subgen. nov. The species fall naturally into these with the exception of *glacialis* and *cordata*, which are allocated arbitrarily.

CODONELLOIDES subgen. nov.

Codonellopsis with small lorica; narrow collar with few spiral turns; bowl without a nuchal extension; aboral end rounded, rarely slightly pointed, never with aboral horn or septum at bottom of bowl; wall of bowl often with irregular agglomerations. Type species *Cdps. contracta* K. and C., from Peruvian Current at Sta. 4655. Includes 21 species, in 4 series, as follows:—the *tuberculata* series, including *tuberculata, ornata, bulbulus,* and *lata;* the *contracta* series, including *contracta, pusilla, inornata, robusta, turgescens, brasiliensis,* and *ecaudata;* the *glacialis* series, including *glacialis* and *lusitanica;* and the *obconica* series, including *obconica, erythräensis, americana, indica, morchella, schabi, ostenfeldi,* and *globosa.*

CODONELLOPSIS subgen. nov.

Codonellopsis with large lorica; wide collar with numerous spiral turns; bowl usually with short nuchal region; definite aboral horn, usually with septum; irregular blobs usually absent. Type species *Cdps. orthoceras* (Hæckel) Jörg. from Messina. Includes 18 species, in 2 series:—the *cordata* series, including *cordata, turbinella, gaussi,* and *brevicaudata;* and the *tropica* series, including *tropica, californiensis, minor, pura, turgida, parva, speciosa, orthoceras, inflata, pacifica, tessellata, meridionalis, longa,* and *biedermanni.*

Codonellopsis americana Kofoid and Campbell

Plate 3, fig. 10

Lorica medium sized, collar and bowl subequal, with oral margin everted, subcylindrical collar, rotund bowl, and subhemispherical aboral end; 2.45–3.58 (2.94) o.d., or 1.38–2.52 (1.94) d. bowl. Oral margin entire, not thickened. Suboral region an inverted cone (65°) 0.1 of collar. Collar an inverted truncate cone (5–8°), 0.27–0.50 (0.43) t.l., or 0.82–2.00 (1.35) o.d., made up of a leiotropic spiral lamina deflected 3–5° from horizontal, a little flatter toward anterior end, with 8–22 (12.5) turns. Lorica with greatest number of turns taken at station with lowest recorded temperature (76°). Turns 0.2 o.d. in width at posterior end, narrowing rapidly in distal fourth to 0.05. Nuchal diameter 0.87–0.97 (0.92) o.d. Bowl rotund ovoidal, expanding abruptly below collar, with shoulder a cone (97°) 0.1 o.d., distinctly

separated from collar by texture and suture; length 0.50–0.73 (0.57) t.l., or 1.42–2.10 (1.70) o.d.; greatest diameter somewhat below middle, 1.42–1.81 (1.55) o.d., or 0.39–0.73 (0.52) t.l. Aboral and subhemispherical, without aboral point. Wall of collar very thin, a trifle thicker near posterior end; its primary prisms faint, with 1–2 elliptical fenestræ, with their long axes horizontal, in 3rd to 5th ring below oral margin. Wall of bowl thicker near aboral end, made up of 1 to 3 layers or irregular, unequal, polygonal tertiary areas which incorporate finer secondary areas within which is a primary mesh of several layers. Outer surface with irregular adherent prismatic blobs. One lorica at Sta. 4624 had *Tintinnopsis beroidea* adherent to shoulder. Animal with 8 ellipsoidal macronuclei.

Ten loricæ: L., total, 76–111 (91.5); collar, 23–54 (38.7); bowl, 45–57 (53.1). D., oral, 29–33 (31.2); neck, 27–31 (28.7); bowl, 44–56 (47.8) μ; spiral turns, 8–22 (12.5).

Gräf's lorica (1909) from off Bougainville in the Western Tropical Pacific called by him *Codonella morchella*, is probably *Codonellopsis indica*.

At 14 stations, viz., at 1, 9, and 4, respectively, in California, and Mexican Currents and Panamic Area; at 76–85 (81.5)°; 200 loricæ.

Codonellopsis biedermanni (Brandt) Kofoid and Campbell

Plate 5, fig. 10

Lorica very greatly elongated, rather large, very narrow, collar shorter than bowl, bowl greatly elongated, slender, pear-shaped; aboral horn stout, blunt; 3.53–4.10 (3.74) o.d., or 3.47–3.73 (3.59) d. bowl. Oral margin irregular, minutely serrate, thickened, and everted in a prominent lip. Suboral cone an inverted, concave, funnel-like cone (41–72°) 0.09 or less of collar. Collar an inverted truncate cone of 5–8° below, 0.36–0.45 (0.40) t.l., or 1.30–1.69 (1.50) o.d., with basal diameter of 0.72–0.82 (0.77) o.d.; made up of a leiotropic spiral lamina deflected 2–7° from horizontal, with least deflection anteriorly, with 21–29 (25.2) turns 0.1 o.d. in width posteriorly, 0.07 near middle, and only 0.04 below oral margin. Serrated outline, due to thickening and emergence of anterior margin of lamina not prominent. Bowl elongated, narrow ovoidal, or very elongated pear-shaped, 0.55–0.64 (0.60) total length, or 1.67–1.95 (1.86) o.d.; divided into an anterior nuchal and a posterior ovoidal region. Nuchal section subconical (14°), 0.23 of bowl in length, with scarcely any shoulder, its anterior diameter 0.86 o.d. contracting

posteriorly as an inverted cone (21°) 0.25–0.35 o.d. in length. Nuchal diameter 0.83 o.d. Ovoidal region 0.32 t.l., or 1.27 o.d.; anteriorly an inverted, truncate cone (30°) 0.60–0.75 o.d. in length; posteriorly an inverted, truncate, convex cone (65°), 0.18–0.21 t.l., or 0.66–0.80 o.d., with greatest diameter (0.95–1.17 [1.04] o.d.) at 0.66–0.72 t.l. from oral margin. Aboral horn a short, blunt, inverted cone (20–25°) 0.32–0.41 (0.36) d. bowl in length, its diameter at septum same as its length. Tip bluntly rounded, with slender canal to end. Wall of collar very hyaline, with meshwork of primary prisms clearly visible, 0.13 o.d. in thickness at oral margin and two-thirds as thick elsewhere. Wall of bowl 0.13 o.d. in nuchal region, 0.17 in middle of bowl, as much as 0.2 in posterior section, 0.16–0.22 in septum, and 0.15 in aboral horn; made up of subuniform, subpolygonal, regular secondary fields, 40–50 across equator and 75–90 from collar to tip of aboral horn. Polygons less regular on rugose horn. Secondary polygons in 1–6 layers in wall. The thick, dense, peculiar brown wall of bowl is unusual in Codonellopsis except in the closely related *biedermanni* and *meridionalis*. Lumen of bowl sinking deeply into base of aboral horn as delimited externally, and usually separated from slender cavity in thick-walled horn proper by a heavy partition. It is not practicable to regard the free connection of the cavity of horn with that of bowl as a specific character, as Brandt (1907) maintains, for some of our otherwise typical loricæ have a complete partition, and in most loricæ the opening between, if present, is difficult to demonstrate. Animal large, filling two-thirds of cavity of bowl.

Four loricæ: L., total, 228–241 (236); collar, 87–105 (94.7); bowl, 110–130 (117.5); aboral horn, 20–26 (23.7). D., oral, 59–67 (63.2); neck, 48–50 (48.5); bowl, 63–69 (65.7) μ.

At 7 stations, viz., at 1 and 6, respectively, in Panamic Area and Drift; at 75–81.5 (79.9)°; 18 loricæ.

Codonellopsis californiensis Kofoid and Campbell

Plate 5, fig. 4

Lorica moderately large, very stout; collar and bowl subequal; bowl rotund, stout; aboral horn rudimentary, blunt, without septum; 2.01–2.80 (2.67) o.d., or 1.72–1.83 (1.81) d. bowl. Oral margin entire, thin, flaring but not everted. Collar an inverted, truncate cone (5–7°) 0.37–0.47 (0.44) t.l., or 1.07–1.30 (1.13) o.d. Suboral funnel a concave, inverted, truncate cone (23–35°) 0.14 length of collar; posterior diameter

0.87–0.92 o.d. Collar subcylindrical below funnel, laterally concave, made up of 13–20 (16.6) turns of a leiotropic spiral deflected about 3° from horizontal. Lamina outwardly concave, thickened and protuberant along anterior margin, 0.12 o.d. in width at posterior end, 0.08 near middle, and only 0.04 in suboral funnel, in loricæ with a short collar less divergent in width. Bowl rotund, stout, with short nuchal region and globose middle section; 0.53–0.63 (0.56) t.l., 1.20–1.55 (1.40) o.d., or 1.12–1.22 (1.17) greatest diameter (1.09–1.26 [1.22] o.d., or 0.30–0.45 [0.40] t.l. at middle). Neck a low, truncate cone (14–26°) 0.13–0.15 of bowl; nuchal diameter 0.87 o.d. Mid-region globose, a trifle elongated. Aboral half elongate subhemispherical or slightly protuberant. Aboral horn very rudimentary, a convex cone (60°) 0.12 of bowl, or 0.57 its basal diameter, without septum. Tip blunt or flattened. Wall of collar hyaline, uniformly thin; that of bowl also relatively thin, very uniform, doubling in thickness at distal end of aboral horn. Wall of bowl dense, with regular, subpolygonal, subequal, rather faint tertiary structures, 15–18 across equator and 18–22 from oral to aboral end, filled with minute, regular, very definite secondary prisms, 4–6 across a tertiary, in 2–5 layers.

Five loricæ: L., total, 134–160 (148); collar, 56–73 (65.4); bowl, 78–88 (82.4). D., oral, 55–65 (57.8); neck, 44–50 (46.8); bowl, 68–72 (70.2) μ.

At 4 stations, viz., at 2 each in California and Mexican currents; at 75–83 (79.2)°; 5 loricæ.

Codonellopsis contracta Kofoid and Campbell

Plate 3, figs. 2, 5, 6, 11, 13

Lorica very small, ovate, with collar of 4–12 turns, shorter than bowl and merging gradually with it, aboral end hemispherical; 2.13–2.42 (2.24) o.d., or 1.28–1.46 (1.36) d. bowl. Oral margin entire. Collar a low, truncated cone (25–40°), 0.28–0.36 (0.31) t.l., or 0.60–0.89 (0.70) o.d., with slight sigmoid or concave lateral outline, made up of an anterior and posterior cone. Anterior cone concave, truncated, inverted, (9–26°) 0.50 of collar or 0.31–0.42 (0.35) o.d. Posterior truncated cone wider (35–60°). Collar a leiotropic spiral of 4–12 (6.8) turns, deflected 3–8° from horizontal with 2–8 turns in anterior and 2–5 in posterior cone. Turns narrower (0.06 t.l.) in anterior and wider (0.11) in posterior cone. Lower margin of spiral lamina thicker than upper. Collar flaring into bowl but separable by structure and texture

of wall, rather than change of contour. Bowl broadly ovoidal, 0.64–0.73 (0.69) t.l., or 1.56–2.73 (2.09) o.d. Anteriorly convex subconical (35–40°). Greatest diameter 1.55–1.84 (1.66) o.d., 1.26–1.47 (1.35) nuchal d., or 0.68–0.78 (0.73) t.l. Aboral end hemispherical without aboral point. Wall of collar of fine very faint, primary prisms; that of the bowl much thicker, 0.13–0.16 o.d. Fenestræ interspersed in spiral lamina, elliptical with longer axis horizontal, nearly as wide as lamina, devoid of prismatic structure, and enclosed in delicate hyaline membrane; 1–7 on one face, in only a single ring, viz., in the second from the rim or in the first to the fifth above the bowl. Wall of bowl dense and opaque, with 7–15 large, subpolygonal, subequal, irregular secondary prisms across its middle, and 10–14 from oral to aboral end, in 2–3 layers, each enclosing 20–60 tiny primary prisms. In loricæ from Sta. 4655 and 4679, the center of each secondary field contained a circular (*Coccolithophora leptopora*) or an oblong (*Syracosphæra*) coccolith.

Eleven specimens: L., total, 42–48 (44.1); collar, 12–16 (13.5). D., oral, 18–22 (19.4); base of collar, 24–29 (26.1); bowl, 30–35 (32.1)μ. Spiral turns 4–12 (6.8). The average of measurements at two ranges of temperature: At 65–67°: L., total, 44.1; collar, 12.8. D., oral, 20.0; base of collar, 26.6; bowl, 33.0μ. At 68–71°: L., total, 43.6, collar, 14.4. D., oral, 18.8; base of collar, 25.4; bowl, 31.0μ. The loricæ in warmer waters are smaller and have a few more rings than those in cooler waters.

At 11 stations in Peruvian Current; at 65–71 (67.7)°; 76 loricæ.

Codonellopsis cordata Kofoid and Campbell

Plate 3, fig. 1

Lorica small, with short collar, wide shoulder, heart-shaped bowl, sharply pointed aboral end, and spine-like aboral horn; 4.37 o.d., or 1.63 d. bowl. Oral margin entire, slightly thickened, everted in a low, inverted cone (45°), 0.03 of collar. Collar cylindrical, 0.32 t.l., 1.26 o.d., or 0.47 d. bowl, a leiotropic spiral of 6 subuniform, outwardly convex turns, deflected 3–5° from horizontal, 0.2 of collar in width. Bowl cordate, with horizontal, outwardly rounded shoulder and rapidly contracting, top-shaped body; length, including aboral horn, 2.58 o.d., 0.58 t.l., or 1.34 its maximum diameter. Flattened shoulder expands subhorizontally to 1.33 o.d., or 0.66 d. bowl, with a shallow depression at base of collar, and greatest diameter (2.31 o.d.) at 0.47 t.l. from oral margin, posteriorly conical, an inverted cone (58°) 0.53 t.l., 1.87

o.d. Aboral horn 0.2 t.l., or 0.28 bowl, an inverted cone (29°) whose base is half of its length in diameter, and with sharp aboral end. Wall of collar with faint primary prismatic structure; that of bowl half again as thick. Wall most peculiar; anterior to 0.45 t.l., it is hyaline, exactly like collar. At the junction a circle of minute dots around bowl, and below this a row of coccoliths of *Coccolithophora wallichi*, which are also scattered over bowl and aboral horn.

L., total, 81; collar, 25; bowl, 49; aboral horn, 8. D., collar, 19; bowl, 44 μ.

Nearest to lorica figured by Entz, Jr. (1908, pl. 4, fig. 5; 1909b, pl. 11, fig. 5), which we named (K. and C., 1929, p. 89) *Cdps. turbinella*, but much smaller (81 μ, as against 135 (200 μ, as stated by Entz)), and its shoulder convex and rounded, as contrasted with cupped and spreading shoulder of *Cdps. turbinella*. It is possible both species are structural monstrosities due to disturbance during formation of lorica.

At Sta. 4709 in Drift; at 72°; 1 lorica.

Codonellopsis ecaudata (Brandt) Kofoid and Campbell

Plate 3, fig. 9

Lorica moderately large, elongated, with distinctly cylindrical collar longer than bowl, aboral end bluntly pointed; 2.84–3.11 (2.97) o.d., or 1.84–2.06 (1.92) d. bowl. Oral margin entire, not thinned, definitely flaring. Collar concave outwardly below margin, abruptly contracting into a low, concave, inverted, funnel-shaped suboral cone (47–55°) 0.07 of collar. Collar a cylinder below suboral cone, 0.47–0.54 (0.49) t.l., or 1.34–1.47 (1.41) o.d.; truncate subconical (5–7°), with greatest diameter (1.03 o.d.) at junction of collar and bowl, or flaring aborally (27°); made up of a leiotropic spiral deflected 2° from horizontal, with 11–12 (11.3) turns of thin, concave lamina, 0.11 o.d. wide at posterior end, 0.13 toward middle, and 0.04 at oral margin, only 1–3 involved in suboral funnel. Bowl stout ovate; 0.46–0.53 (0.51) t.l., 1.50–1.70 (1.58) o.d., or 1.00–1.12 (1.08), greatest diameter (1.42–1.53 [1.48] o.d.) at 0.67–0.74 (0.68) t.l. from oral margin, separated from collar by distinct suture, broadly ovoidal, with tendency to aboral elongation. Aboral region a little contracted to a rounded end. Wall of collar uniformly thin; of bowl much thicker, thinning toward aboral end, with 1–3 elliptical or subcircular fenestræ, closed by delicate membrane. Wall of bowl of distinct, regular, subangular secondary prisms, 35–40 across one face and 38–47 from oral to aboral

end, included in fainter, less regular, and more angular meshwork of tertiary fields, 12–15 across one face and 12–16 from oral to aboral end. Secondary prisms in 2–3 layers in the wall, and walls of tertiary fields rather thick.

Three loricæ: L., total, 95–100; collar, 45–47; bowl, 50–55. D:, oral, 32–37; neck, 31–37; bowl, 47–50μ, number of turns 11–12.

At 6 stations, viz., at 5 and 1, respectively, in Drift and Galapagos Eddy; at 72–75 (74)°; 34 loricæ.

Codonellopsis inflata Kofoid and Campbell

Plate 5, figs. 3, 6, 12

Lorica large, robust, with collar and bowl subequal, no nuchal constriction, short, very rotund bowl, and long aboral horn; 3.00–3.60 (3.44) o.d., or 2.21–2.99 (2.60) d. bowl. Oral margin entire, thin, and abruptly everted. Collar an inverted, truncate cone (3–12°) 0.31–0.42 (0.37) t.l., or 0.92–1.46 (1.29) o.d., with a short suboral funnel and long subcylindrical section. Suboral funnel a short, concave, inverted, truncate cone (42–75°) 0.06–0.09 of collar, and with posterior diameter 0.88–0.96 o.d. Subcylindrical section of collar with no lateral concavity, basal diameter 0.80–0.88 (0.83) o.d., made up of a leiotropic spiral deflected 2–3° from horizontal, with 14–33 (20) turns. Seven loricæ, at 72°, had 14–19 turns, with one exception having 26 turns, at 75° one lorica had 22, and at 77° one lorica had 33. No overlapping in most loricæ of anterior margin of lamina upon turn above, but in others considerable overlap, local irregularity, and wavy margins. Turns outwardly concave, so that lateral outlines of collar are serrate, variable in width, narrow and crowded suborally; 0.1 o.d. in width in posterior half of collar, 0.07 near middle, and suborally reduced to 0.04. A lorica from Sta. 4709 had a collar made up of three zones, suggesting that the formation of the lorica had been interrupted twice. Bowl with a short neck, very rotund, 0.36–0.47 (0.44) t.l., or 0.92–1.62 (1.29) o.d. in length. Neck 0.14–0.17 of bowl, its posterior diameter 1.03–1.11 o.d., in a few loricæ turban-like. Posterior section of bowl 0.81–0.86 its length, almost spheroidal, becoming distinctly conical (85–90°) distally as it contracts to aboral horn; greatest diameter (1.18–1.38 [1.31] o.d., or 0.36–0.61 [0.38] t.l.) at 0.56–0.59 t.l. from oral margin. Aboral horn a cone (16–27°) 0.20–0.24 (0.21) t.l., or 0.67–0.84 (0.73) o.d., with base 0.25 of bowl. Tip blunt or truncate, its contour frequently irregular or asymmetrical. Wall of collar with

fine, faint meshwork of primary hexagons, uniformly thin. Wall of bowl thicker, uniformly graduated made up of small, uniform, subpolygonal secondary prisms, 60–70 across one face and 70–90 from oral to aboral end. A faint tertiary meshwork underlies secondary structure, of larger but less uniform dimensions, 20–25 across equator and 20–35 from end to end. A peculiar type of fenestration occurs in many loricæ from western part of Drift, in which circular fenestræ occur throughout whole bowl, or only in a wide band across equator, or irregularly distributed, in which secondary mesh is wholly lacking and the surface is pitted or depressed. Twenty such fenestræ occur across equator, separated by intervening secondary mesh. A thin, uniform, hyaline lamina lines the bowl. Secondary structures in 2–5 layers and tertiary in one. A globular body, probably a cyst, filled cavity of bowl in one lorica.

Ten loricæ: L., total, 130–224 (202.6); collar, 75–86 (81.8); aboral horn, 29–52 (43.5). D., oral, 56–63 (59.8); neck, 47–52 (49.3); bowl, 70–83 (77.9) μ.

At 18 stations, viz., at 1, 1, and 16, respectively, in South Equatorial Current, Galapagos Eddy, and Drift; at 68–81 (73.4)°; 129 loricæ.

Codonellopsis longa Kofoid and Campbell

Plate 4, figs. 5, 7, 9, 11

Codonella morchella, Gräf, 1909, p. 191, fig. [27] b.

Cdps. orthoceras, partim, Hofker, 1931b, pp. 367–369, figs. 47a-b (for figs. 48, 48A see *Cdps. speciosa*).

Lorica very greatly elongated, very large, with collar much longer than bowl, slightly flaring as a whole; bowl with pronounced nuchal constriction, pear-shaped, subconical posteriorly; long, slender aboral horn; 4.10–5.12 (4.70) o.d., or 3.28–4.03 (3.84) d. bowl. Oral margin entire, very thin, with occasional blobs on rim. Collar 0.35–0.50 (0.42) t.l., 1.56–2.33 (1.97) o.d., or 0.75 or more of bowl and horn. Suboral funnel short, very concave, inverted, truncate cone (36–75°) 0.02–0.07 collar, with posterior diameter of 0.84–0.97 o.d., with basal diameter of 0.73–0.85 (0.80) o.d. Tubular section subconical (3–8°). Collar a leiotropic spiral lamina deflected 2–6° from horizontal, steepest in posterior half, with 19–33 (27.1) turns. Number of turns at 68–79 (74.1°) was 23–29 (28.8), whereas one lorica at 81° had only 19 turns. Loricæ with 33 turns occurred at 72 and 79°. Anterior margin of lamina even, but may have local wavy, or deeply notched depressions,

filled in by material of turn above. Upper edge of lamina thickened and everted, causing slightly serrate lateral outlines. Turns 0.13 o.d. in width posteriorly, decreasing to 0.08 near suboral funnel. Bowl slender, elongate pear-shaped, 0.27–0.38 (0.33) t.l., or 1.27–1.74 (1.57) o.d. This range is brought about by elongation, principally in neck and also in aboral hemisphere. Bowl divided into variable neck region with ill-defined posterior limit, and an elongate ovoidal posterior region. Neck an inverted, truncate cone (15–20°) 0.14–0.20 of bowl, turban-like, 0.87–1.00 o.d. in diameter, contracting below in an inverted cone (19–27°). Nuchal diameter 0.76–0.87 o.d. at 0.41–0.53 t.l. from oral margin. Ovoidal region with greatest diameter 1.14–1.34 (1.23) o.d., or 0.24–0.30 (0.25) t.l., at 0.57–0.62 t.l. from oral margin. Aboral horn very long, slender, tapering, 0.55–0.84 (0.72) length of bowl, an inverted cone (4–10°) flaring basally. Diameter at base 0.33, and at tip, 0.16 d. bowl, irregular in outline, or asymmetrical. Tip squarely or obliquely truncate, or indented. Wall of collar with faint mesh, 14 across lamina and 150 across collar. Wall of bowl much thicker; very characteristic in that secondary fields are regularly polygonal, uniform in size, about 100 across one face at equator, and 120 from oral to aboral end of bowl. Tertiary fields usually much fainter, 22–35 across equator and 27–35 from oral to aboral end of bowl, less regular in outline and less uniform in size than secondary prisms which they enclose, especially in equatorial region. Primary prisms very faint, 4–10 within each secondary. Fenestræ like those of *Cdps. inflata* and *pura* in several loricæ at Sta. 4681. Wall made up of a heavy uniform inner lamina, 3–5 layers of secondary prisms, and very thin outer lamina. At Sta. 4724 loricæ contained numerous rhabdoliths of *Rhabdosphæra claviger* and coccoliths of *Syracosphæra pulchra*. At Sta. 4734 loricæ had many *Umbilicosphæra mirabilis* on bowl, and one had equidistant hemispherical bosses on equator filled with secondary prisms. Animal rather large, filling bowl and part of collar even when contracted, with 18–20 membranelles.

Ten loricæ: L., total, 235–294 (271.7); collar, 86–143 (113.9); bowl, 78–103 (90.8); aboral horn, 60–80 (65.1). D., oral 55–62 (57.6); neck at base of collar, 44–48 (46.2); bowl, 63–75 (70.8)μ.

At 15 stations, viz., at 2, 1, 3, and 9, respectively, in Peruvian and South Equatorial Currents, Easter Island Eddy, and Drift; at 68–82 (74.5)°; 99 loricæ.

Codonellopsis meridionalis Kofoid and Campbell

Plate 5, figs. 9, 11

Lorica large, rather stout, with collar and bowl subequal; rotund, pear-shaped bowl and long, narrow, subconical aboral horn; 3.12–3.96 (3.72) o.d., or 2.67–3.48 (3.17) d. bowl. Oral margin entire, thin, and abruptly flaring. Suboral cone an inverted, slightly concave cone (53–80°) 0.05–0.13 of collar. Collar below suboral cone an inverted, truncate cone (3–6°) 0.33–0.41 (0.36) t.l., or 1.18–1.55 (1.36) o.d., and basal diameter 0.77–0.93 (0.81) o.d.; a leiotropic spiral deflected 2–5° from horizontal, with 21–39 (25.4) turns. Anterior margin of lamina thickened, everted, and scarcely concave outwardly. Turns 0.13 o.d. in width near posterior end, 0.8 above middle, and decrease to 0.04 or less below oral margin. In some loricæ curved oblique sutures cross the lamina, suggesting an interruption in its formation. Bowl elongated, rotund pear-shaped; 0.59–0.67 (0.64) t.l., or 1.36–1.61 (1.55) o.d. Divided into an anterior nuchal region and a posterior ovoidal, almost biconical part. Nuchal section inverted subconical (15–22°) 0.19 of bowl, with sigmoid contour, in some loricæ subcylindrical, and in others scarcely differentiated, its length being less than 0.06 of bowl. Nuchal diameter 0.77–0.83 o.d. Ovoidal section divided into an anterior convex truncate cone (22–45°) 0.10–0.17 (0.13) t.l. or 0.41–0.52 (0.46) o.d., and a posterior inverted cone (69–82°) 0.18–0.27 t.l., or 0.65–0.79 o.d., with greatest diameter (1.11–1.34 [1.18] o.d.) at 0.60–0.65 (0.63) t.l. from oral margin. Aboral horn long, its length measured from septum to tip 0.14–0.26 (0.17) t.l., or one-half of length of bowl proper, forming an inverted cone (12–21°) with a broadly rounded, often obliquely truncate tip. Wall of collar uniformly thin, with faint meshwork of primary prisms. Wall of bowl of subuniform, subpolygonal secondary fields, 40–50 across equator and 45–57 from oral to aboral end. Tertiary areas lacking, but loricæ from Sta. 4722 with fields less polygonal and more subcircular. Polygons of aboral horn very irregular in contour, making it rugose. Secondary polygons in 2–3 layers. The dense, brownish-colored wall resembles that of *Cdps. biedermanni*.

Nine loricæ: L., total, 197–257 (231.5); collar, 68–100 (84.9); bowl, 85–103 (96.5); aboral horn, 32–50 (40.1). D., oral, 55–65 (62.1); collar at base, 47–52 (50.3); bowl, 68–76 (73)μ. Both longest (257μ) and shortest (197μ) loricæ occur at lower level of temperatures at which loricæ were measured, namely, 75°, while those taken between 81 and 84° were intermediate in length.

At 25 stations, viz., at 1, 10, 1, 1, 1, 3, 1, and 7, respectively, in

California, Mexican, Peruvian, South Equatorial, and Equatorial Counter currents, Panamic Area, Galapagos Eddy, and Drift; at 78–85 (80.9)°; 100 loricæ.

Codonellopsis minor (Brandt) Kofoid and Campbell

Plate 4, figs. 2-4, 10

Lorica of medium size, with collar always shorter than bowl, elongated subglobose bowl with well developed neck, and short, stout aboral horn; 2.88–3.28 (3.05) o.d., or 2.19–2.64 (2.40) d. bowl. Oral margin entire, thickened, widely everted. Collar an inverted, truncate cone (8–12°) 0.30–0.45 (0.38) t.l., 0.93–1.41 (1.15) o.d. Suboral funnel an inverted, outwardly concave, truncate cone (40–75°) 0.05–0.17 of collar; posterior diameter 0.79–0.91 o.d. Collar tapering, an inverted, truncate cone (3–5°) decreasing regularly to its aboral end; posterior diameter at end 0.77–0.87 (0.84) o.d., not laterally concave, a leiotropic spiral lamina deflected 1–3° from horizontal, with 12–21 (15.6) turns. In a lorica from Sta. 4594 (Plate 4, fig. 4) collar had a proximal region (0.6) with 12 wide turns, and a distal (0.4) with 25 narrow rings each less than 1 μ in width. The number of turns is less in loricæ in warmer waters than in cooler ones. Lamina thickened and everted along its anterior margin and outwardly concave, with little overlap and some waviness in anterior and middle region of a few loricæ. In one lorica two turns of lamina are joined across an intermediate one by an oblique suture line. Turns 0.10–0.14 o.d. in width in posterior half, 0.05–0.08 adjacent to suboral funnel, and 0.03 in funnel. In the peculiar lorica from Sta. 4594 with two zones of rings, there are numerous fenestræ of elongate, irregular form on posterior 0.6 of collar. All other loricæ lack these fenestræ. Bowl elongated, 0.41–0.58 (0.52) t.l., 1.11–1.40 (1.24) greatest diameter, or 1.49–1.80 (1.56) o.d. Neck inflated, turban-like, 0.12–0.23 of bowl. Bowl proper elongated globose, with greatest diameter (1.19–1.37 [1.24] o.d.) postmedian, at 0.60–0.65 t.l. from oral margin. Aboral horn a stout cone (32–40°) 0.08–0.14 (0.11) t.l., or 0.24–0.44 (0.33) o.d. with septum. Tip bluntly rounded or irreglarly truncated or bent. Wall of collar uniformly very thin, with primary mesh; of bowl thicker, increasing near distal end of aboral horn, composed of tertiary mesh of uniform, subregular, polygonal fields, 20–25 across one face at equator and 25–35 from end to end, filled by small, subpolygonal, uniform secondary meshwork, 60–90 across bowl at equator. In some loricæ there is also an equatorial zone of few or

numerous fenestræ, especially in hauls from 67–69° in Peruvian Current. At Sta. 4666 (Plate 4, fig. 2) coccoliths were abundant over whole bowl from throat nearly to base of horn, leaving only narrow interstices in which secondary mesh appears. On one bowl (Plate 4, fig. 10) coccoliths of *Coccolithophora leptopora* and *C. pelagica* were equally abundant and interspersed among these were smaller ones of *Syracosphæra mediterranea* and *Pontosphæra hæckeli*. Coccoliths occurred less frequently in this species than in others at the same stations. Laackmann (1909) finds small loricæ in the Atlantic near Ascension bearing "Tupfelporen," but fails to interpret them as coccoliths. His statement that "Tupfelstructur" is confined to loricæ taken near the coast is not borne out by our data on this and many other species, Sta. 4666 being, for example, over 400 miles from shore, and the plankton taken there is strictly oceanic in character. A thin hyaline lamina lines cavity of bowl and horn. Wall of a single layer of tertiary fields and 3–5 layers of secondary prisms. Animal fills over 0.7 of cavity of bowl, has 9–16 membranelles and a conical closing-apparatus.

Ten loricæ: L., total, 161–190 (171.9); collar, 52–78 (64.8); bowl, 80–101 (88.7); aboral horn, 16–26 (18.4). D., oral, 53–59 (56.4); neck, 43–49 (47.1); bowl, 69–75 (71.5)μ.

In the colder waters of the Peruvian Current there is a considerable degree of fenestration of bowl, and a smaller proportion near Sta. 4666 bear coccoliths. The length of 15 loricæ in warmer waters (79–83°) is 150–188 (169)μ, while in colder waters (67–73°) range is nearly the same (150–190μ), but the average length (22 loricæ) is 172μ. The difference is slight, but its direction is significant. While the collar tends to be longer in the colder regions, the number of rings tends to be less, and vice versa in the warmer waters. The length of collar in 22 loricæ from colder waters (67–73°) is 55–86 (67.6)μ, while in 15 loricæ from warmer waters (79–83°) this is 52–76 (64.2)μ. The number of rings is 12–19 (16) for the colder region, and 13–21 (15.7) for the warmer. In brief, more rings tend to be formed of less material (in less time?) in warmer waters than in colder ones, an illustration of the operation of Van't Hoff's law recorded in these secreted and shaped-up structures of the Tintinnoinea.

At 41 stations, viz., at 1, 5, 16, 1, 1, 8, 1, 4, and 4, respectively, in California, Mexican, Peruvian, North Equatorial, and South Equatorial currents, Panamic Area, Galapagos and Easter Island eddies, and Drift; at 67–84 (73.1)°; 176 loricæ.

CODONELLOPSIS PACIFICA (Brandt) Kofoid and Campbell

Plate 4, figs. 1, 6

Lorica elongated, with collar shorter than bowl and horn, stout bowl with turban-like neck, long subcylindrical aboral horn; 3.18–4.40 (3.81) o.d., or 2.64–3.50 (3.13) d. bowl. Collar 0.36–0.43 (0.38) t.l., or 1.13–1.73 (1.43) o.d., an inverted, truncate cone (6–9)°. Oral margin thin, entire, and abruptly everted. Suboral funnel an inverted, truncate cone (55–83)° 0.03–0.05 of collar, with posterior diameter of 0.92–0.94 o.d., and basal diameter of 0.78–0.92 (0.82) o.d. Collar a leiotropic spiral deflected 3–6° from horizontal, with 16–23 (20) turns of spiral lamina. Loricæ with most turns occur at higher temperatures than those with fewest. Upper margin of lamina slightly thickened, with little projection, slight concavity of outer face, in some loricæ very wavy and irregular. Turns subuniform in width in most loricæ, especially in posterior 0.75 (0.08–0.10 o.d.), but less than 0.03 in funnel. In loricæ at Sta. 4742 fifteen elliptical closed fenestræ resembling those on bowls of other loricæ occurred along upper margins of most of the 16 turns. Such fenestræ occur on collar of this and other species and represent a food element derived from some widely distributed pelagic microorganism not referable to a known coccolith. Bowl divided into distinct neck and globose region. Neck turban-like, with a length of 0.15–0.18 of its diameter. Nuchal diameter 0.83–0.96 o.d. Posterior part of bowl anteriorly spheroidal, posteriorly convex subconical (70–85°), 0.24–0.33 (0.29) t.l. Greatest diameter (1.14–1.38 [1.22] o.d.) at 0.50–0.59 t.l. from oral margin. Aboral horn slender, elongated, subcylindrical, 0.23–0.29 (0.26) t.l., or 1 o.d. Diameter at middle 0.15–0.22 o.d. Tip blunt, contour often irregular. Septum recessed. Wall of collar with faint meshwork of subhexagonal prisms, 4–8 across lamina and 150 across turn. Wall of bowl thicker, thinning at tip, filled with coccoliths, especially at Sta. 4724 and 4732, principally *Coccolithophora leptopora* and *pelagica*, while at Sta. 4742 the peculiar projecting hemispherical bosses on the equator characteristic of *Cdps. parva*, *longa*, and *speciosa*, were found on one lorica. Circular or oval fenestræ were found on equator of several loricæ in an irregular row, 8–10 across one face. Surface of bowl between coccoliths and fenestræ, and whole surface when these are absent, filled with a distinct subpolygonal tertiary meshwork of irregular size, 16–24 across bowl and 25–40 from end to end, smaller at nuchal and aboral ends than in middle. Each encloses 10–18 smaller subcircular secondary areas, 200 across equator, and 300 from oral to aboral end. Tertiary areas in 1–3 layers, secondary prisms

within them in 2–4. A thin inner and an outer hyaline lamina on collar, and an inner one lining the bowl, between which prismatic structures are enclosed. Animal large, more than filling bowl, with a single oval macronucleus 7 by 10μ.

Eight loricæ: L., total, 190–225 (213); collar 68–96 (80); length of bowl, 71–85 (78); aboral horn, 44–64 (55). D., oral, 50–60 (56); collar at base, 44–47 (46); bowl, 64–72 (68)μ.

At 5 stations, viz., at 1 and 4, respectively, in South Equatorial Current and Drift; at 72–79 (76.4)°; 27 loricæ.

Codonellopsis parva Kofoid and Campbell

Plate 5, figs. 2, 5

Lorica medium sized, short, not stout; with collar shorter than bowl; flaring, distinct neck; ovoidal bowl, and tapering, rather long, stout aboral horn; 2.92–3.28 (3.12) o.d., or 2.29–2.76 (2.46) d. bowl. Oral margin thickened, not everted. Collar an inverted, truncate cone (7–14°) 0.29–0.40 (0.32) t.l., or 0.87–1.22 (0.98) o.d. Suboral funnel indistinct, laterally concave, a leiotropic spiral uniformly deflected 2–5° from horizontal, with 11–17 (14.3) turns of spiral lamina. Number of turns not proportional to height of collar, short collars often having more rings than long ones. Number appears to bear no relationship to temperature. At 70° collars have 15 turns, at 80°, 16, and at intermediate temperatures 11–17. Little overlap of turns and no concavity. Turns 0.14 o.d. in width posteriorly, 0.08 in upper third, and 0.03 near oral margin. Irregular, oval, closed, fenestræ in lamina in middle of collar, with long axis vertical. Tiny adherent coccoliths on collar and oral margin. Bowl rotund ovoidal, 0.38–0.48 (0.44) t.l., or 1.11–1.46 (1.36) o.d. Neck a truncated segment of a cone (12–17°) 0.07–0.15 of bowl. Shoulder abrupt. Ovoidal part of bowl 0.85–0.93 of whole bowl, 1.42–1.57 (1.50) o.d., or 0.35–0.44 (0.40) t.l. in diameter at widest part, 0.6 of length from nuchal suture to septum. Aboral horn elongated, tapering, conical (12–25°), 0.52–0.85 (0.72) o.d. in length. Tip blunt, truncate, deflected, or sinuous. Wall of collar with primary meshwork of 8–14 hexagons across a turn. Wall of bowl thickest at oral end and equator, and thinnest in aboral horn. Septum very thin and recessed. Wall of bowl not uniform in structure in the many loricæ referred to this species. Segregation into systematic entities on the basis of wall pattern is not supported by other structural characters. The following structural types of wall pattern occur within the species: (1) With

umbonate hemispherical or lenticular inclusions at equator. (2) With numerous circular fenestrations in equatorial zone. (3) With small fenestræ of varying dimensions scattered irregularly over bowl. (4) With numerous small, less regular secondary fields, with few irregular tertiary fields, and no fenestrations. (5) With modifications of all of the above due to coccoliths.

The general groundwork of these structural forms is a fairly regular meshwork of uniformly rounded tertiary fields, 25–40 across one face. Into this pattern are interjected fenestræ and bosses. Brandt (1907, p. 113) designates this mesh as tertiary, the fine meshwork within each as secondary, and adds that the primary is very fine. Similar conditions prevail in our loricæ. A very thin lamina lines cavity of bowl. Tertiary mesh in one layer enclosing 2–4 layers of secondary prisms. Coccoliths, coccospheres, and discoliths were found on many loricæ, principally the smaller ones of *Syracosphæra robusta*, *S. spinosa*, and *S. sp.* Loricæ with umbonate inclusions commonly covered by a crust of coccoliths.

Ten loricæ: L., total, 157–177 (167.3); collar, 45–66 (53.5); bowl, 62–81 (73.8); aboral horn, 28–47 (39.8). D., oral, 51–59 (54.8); neck, 42–49 (45.5); bowl, 62–71 (68.1) μ.

At 23 stations, viz., at 1, 1, 1, 1, and 19, respectively, in South Equatorial and Equatorial Counter currents. Panamic Area, Galapagos Eddy, and Drift; at 70–82 (75.7)°; 124 loricæ.

Codonellopsis pura (Brandt) emended Kofoid and Campbell

Plate 4, fig. 12

Lorica short and very stout, with collar shorter than bowl; bowl without well developed neck, very stout ovoidal, with short aboral horn; 2.50–2.72 (2.66) o.d., or 1.90–2.37 (2.03) d. bowl. Oral margin thin, gradually and but slightly everted. Collar an inverted, truncate cone (7–12°) 0.31–0.41 (0.35) t.l., or 0.83–1.14 (0.93) o.d. Suboral funnel a concave, inverted, truncate cone (20–30°, exceptionally 53°) 0.14–0.34 of collar; posterior diameter 0.88–0.92 o.d. Posterior section of collar cylindrical or an inverted, truncate segment of a cone (5°). Nuchal diameter 0.75–0.90 (0.84) o.d. Collar a leiotropic spiral lamina deflected 2–5° from horizontal, with localized steeper deflections in middle, or minor ones distally and proximally, with 12–15 (14.3), rarely 19, turns. An uncompleted lorica had only 4 turns. Loricæ with fewer turns at higher temperatures than others, with exceptions.

Suboral funnel with 3–9 turns. Upper edge of lamina protruding more than lower, resulting in concave outer surface. Below oral margin turns 0.05 o.d. wide, 0.05–0.09 in middle, and 0.07 near neck. Fenestræ lacking. Bowl very wide, globose, 0.44–0.54 (0.50) t.l., or 1.13–1.40 (1.33) o.d., with neck and globose body section. Neck 0.10–0.18 of bowl, gradually flaring with little differentiation into bowl proper, more in our loricæ than in Brandt's. Bowl proper globose or very broadly ovoidal, less convex anteriorly and tending to be subconical (90–110°) aborally; vertical diameter to aboral partition equals greatest transdiameter, which is 1.6 nuchal, or 1.19–1.44 (1.30) o.d., or 0.43–0.53 (0.48) t.l., located near middle of bowl. Aboral horn short, stout, tapering to blunt end, in a few loricæ cylindrical except at tip, a cone (18–35°) 0.13–0.17 (0.15) t.l., or 0.33–0.41 (0.39) o.d., with septum. Tip bluntly rounded, bent to one side, or irregularly truncated. Wall of collar with 8–10 subuniform subpolygonal primary prisms from oral to aboral edge across a spiral lamina; of bowl thickest at equator, and thinning at distal end of aboral horn. Partition separates cavity of bowl from that of horn. Wall of bowl throughout all the varied forms included in the species is consistently made up of an outer film of small, regular, uniform, polygonal secondary fields. Beneath it lies a thicker layer of 1–2 prisms of larger, less regular polygonal tertiary fields, less uniform in size. Secondary prisms 40–90 across one face of bowl at equator, and tertiaries 10–30. Wall dark, grayish-brown, resembling *biedermanni*. There seems to be no satisfactory ground for distinguishing Brandt's varieties *g* and *h* as subspecies or as other taxonomic categories on the basis of relative distinctness of secondary and tertiary meshwork. Loricæ in the eastern end of the region in which we found this species are marked by the presence of fenestra-like circles or ellipses across the equator of the bowl, comparable with similar areas to which Brandt gives the name fenestra in his variety *i*. In fact, this seems to be the only structure which is characteristic of his variety. Since these same structures appear in *C. longa*, *minor*, and *inflata* in the same territory and also in *Codonella amphorella*, *apicata*, and *elongata*, it has seemed best not to give to them a separate taxonomic status. These fenestræ may be locations from which coccoliths have disappeared or in some unknown way determined the location and shape of these areas. In the loricæ with these fenestræ the secondary fields are arranged around each in a regular fashion with radially placed walls. Coccoliths of *Coccolithophora leptopora* were noted in loricæ from Sta. 4722, 4724, 4732, and 4734, all stations in midocean. Wall of bowl and aboral horn lined by thin

hyaline lamina. Tertiary areas in a single layer enclosing 3-5 layers of secondary prisms.

Ten loricæ: L., total, 139–170 (153); collar, 48–70 (53.8); bowl, 68–86 (76.5); aboral horn, 20–26 (22.7). D., oral, 51–63 (57.8); neck, 45–51 (48.6); bowl, 70–80 (75.3)μ.

Some, but not all, loricæ in colder waters, as at Sta. 4705 at 72°, are larger (170μ), and some, but not all, in warmer waters, as at Sta. 4742 at 77°, are smaller (145μ). At Sta. 4722 at 75° the smallest occurred (139μ). The aboral horn in loricæ from cooler waters is longer than in those from warmer waters.

At 28 stations, viz., at 2, 23, 1, 1, and 1, respectively, in Galapagos Eddy, Drift, Peruvian, North, and South Equatorial currents; at 68–82 (75.6)°; 85 loricæ.

Codonellopsis robusta Kofoid and Campbell

Plate 3, fig. 8

Lorica small and stout, stout collar shorter than bowl with little oral flare, bowl broadly ellipsoidal, and wall with many small secondary areas; 2.2–2.8 o.d. or 1.66–1.68 d. of bowl. Oral margin entire, thick, not much flare immediately below it. Collar subcylindrical, 0.4 t.l. or 2.22–2.37 o.d., a leiotropic spiral deflected 2–4° from horizontal, with 9–11 outwardly concave turns of thick lamina, 0.11 o.d. in width in middle and only 0.04 near anterior end. Only 2–3 turns involved in suboral flare. Bowl broadly ellipsoidal, stout, 0.6 t.l., 2.22–2.48 o.d., or 0.94–1.03 d. Shoulder gently sloping. Bowl broadly ellipsoidal, greatest diameter (1.33–1.38 o.d.) at 0.33–0.50 its length from anterior end. Aboral end hemispherical, or a bit elongated, with no point. Wall of collar with primary prismatic structure indistinguishable, uniform in thickness; fenestræ elliptical, 1 or 2 in the 3rd to 6th turn from anterior end, as wide as lamina, and closed by delicate membrane. Wall of bowl thickest across equator, and elsewhere thinner, dense, made up of numerous small subangular, regular secondary prisms in 2–3 layers, 19 across equator and 19 from end to end of bowl. Tertiary structures large, faint, subangular, unequal, 13 across equator and 12 from end to end.

Two loricæ: L., total, 75–84; collar, 30–34; bowl, 45–50. D., oral, 34; neck, 32; bowl, 45–47μ.

At 2 stations in Mexican Current; at 82–84°; 2 loricæ.

Codonellopsis speciosa Kofoid and Campbell

Plate 5, figs. 7, 8

Cdps. orthoceras, partim, Hofker, 1931b, pp. 367–369, figs. 47a-b (for figs. 48, 48A see *Cdps. speciosa*).

Lorica moderately large, robust, somewhat elongated; collar slightly everted, subcylindrical, with little lateral concavity; bowl fairly long, with long neck, not greatly inflated; moderately elongated aboral horn; 3.25–3.54 (3.42) o.d., or 2.29–3.11 (2.69) d. bowl. Oral margin entire, thin, and gradually everted. Collar, an inverted truncate cone (2–4°) 0.31–0.40 (0.36) t.l., or 1.04–1.47 (1.25) o.d. Suboral funnel not localized. Collar a leiotropic spiral deflected 1–3° from horizontal, with 13–26 (18.3) turns of spiral lamina. Loricæ at 69° had fewest turns (16), and those at 81° the most (26), and those at intermediate temperatures had intermediate numbers, with the exception of one lorica, possibly not completed, at 72° with 13 turns. Upper edge of lamina everted, so that lateral outline of collar is serrate. Turns subuniform in width in posterior 0.75 of collar, 0.07 o.d., narrowing below oral margin. One lorica at Sta. 4617 had 1 or 2 tiny circular fenestræ on the middle ten rings. Bowl with well defined neck and broadly ovoidal postcrior section. Neck a turban-like truncated inverted cone (33–40°) 0.12–0.17 of bowl. Posterior section 0.81–0.91 of bowl, or 0.42–0.50 (0.44) t.l., with greatest diameter (1.14–1.42 [1.26] o.d., or 0.32–0.43 [0.37] t.l.) at 0.52–0.60 t.l. from oral margin. Aboral horn 0.38–0.50 (0.44) of bowl, subconical (10–20°), its base less than 0.33 d. bowl, frequently irregular or sinuous in outline, and often asymmetrical. Tip rounded or obliquely truncate. Septum recessed. Wall of collar with faint network of primary hexagonal prisms. Wall of bowl thickest at equator, thinnest at tip of aboral horn, made up of faint to distinct, subregular, subequal, polygonal tertiary fields, 20–30 across equator and 17–29 from oral to aboral end, each filled with 10–20 smaller, regular, hexagonal secondary areas. Secondary polygons so small as to suggest that they belong in the primary category, 60–100 areas across equator, and 90–150 from oral to aboral end. Tertiary areas in one layer, secondaries in 1–3, with a thin hyaline lamina lining cavity of bowl. Oval or elliptical fenestræ in a few loricæ across equator of bowl. One lorica at Sta. 4617 had a hemispherical boss on equator similar to those in wall of *Cdps. parva, longa,* and *pacifica*. Animal large, filling larger part of both collar and bowl, with 9 membranelles across one side, and three oval macronuclei each 10 by 14 μ, and a ciliary membrane.

Six loricæ: L., total, 181–224 (202.5); collar, 57–90 (74.3); bowl, 85–94 (90.3); aboral horn, 34–44 (39.3). D., oral, 56–63 (59.3); base of collar, 49–53 (57.5); bowl, 72–79 (75.3)μ.

At 8 stations, viz., at 1, 1, 1, and 5, respectively, in California and South Equatorial currents, Panamic Area, and Drift; at 68–80 (74.5)°; 22 loricæ.

Codonellopsis tropica Kofoid and Campbell

Plate 5, fig. 1

Lorica of medium size, with collar and bowl subequal, collar laterally strongly concave, bowl widest in anterior quarter and posteriorly convex subconical, and short, blunt aboral horn; 2.32 o.d., or 2.14 d. bowl. Oral margin thickened, everted in an outwardly concave inverted cone (85°) 0.18 t.l. Collar 0.52 t.l., or 1.2 o.d., truncate, inverted subconical (10°), flaring aborally, of 16 leiotropic turns, deflected 5–10° from horizontal, with irregular anterior margin of lamina; width of turns 0.12 length of collar, but anterior six reduced to half or less of this, merging gradually with bowl, without shoulder. Bowl biconical. Anterior cone (38°) truncated, 0.25 of bowl, with scarcely convex sides; greatest diameter (1.08 o.d., or 1.29 nuchal d.) at 0.4 t.l. below oral rim. Posterior cone an inverted, convex segment (63°) 0.75 of bowl. Aboral horn blunt, rudimentary, approximately conical (47°); length 0.56 of its basal diameter. Wall of collar delicate, with fine primary structure and no fenestræ. Wall of bowl dense, heavy, much thicker with 2–3 layers of subpentagonal or subhexagonal secondary prisms, 25 across middle of bowl and 35 from oral to aboral end, each enclosing 5–8 smaller prisms, with irregular blobs on anterior half of bowl and base of collar, as in many neritic species. A septum in aboral horn half as thick as wall of bowl.

L., total, 125; collar, 65; bowl, 53; aboral horn, 7. D., oral, 54; nuchal, 45; bowl, 58μ.

At Sta. 4709 in Drift; at 72°; 1 lorica.

Codonellopsis turgescens Kofoid and Campbell

Plate 3, fig. 4

Lorica moderately large with collar and bowl subequal; collar with everted rim and bulging middle; elongate bowl; barely pointed subconical aboral end; 2.37–3.33 (2.78) o.d., or 1.75–2.08 (1.91) d. bowl. Oral margin entire, thin, and everted, suboral funnel a concave in-

verted cone (23–34°) 0.05–0.08 of length of collar. Collar a bulging cylinder, 0.36–0.50 (0.42) t.l., or 0.92–1.35 (1.13) o.d., greatest diameter 1.08–1.13 o.d., a leiotropic spiral 2–4° from horizontal, with least deflection in turns nearest to anterior and posterior ends, with 8–14 (11.5) turns of deeply concave, thin lamina, narrowing near rim. Suture line acutely emergent. Bowl elongate ovoidal, 0.50–0.64 (0.58) t.l., 1.35–1.73 (1.57) o.d., or 0.96–1.21 (1.11) its diameter, with sloping shoulder, and greatest diameter (1.38–1.47 [1.41] o.d.) at middle. Aboral region convex subconical. Aboral end broadly rounded. Wall of collar thickening aborally. Wall of bowl twice as thick, thinning near anterior and posterior ends. Spiral lamina of collar with 1–3 elliptical fenestræ, closed by a delicate membrane, located in 5th to 7th turn from oral margin. Wall of bowl dense, made up of distinct, regular subangular prisms, 35–41 across equator and 39–50 from oral to aboral end, included in a very faint, much less regular, and angular meshwork of tertiary areas, 13–16 across equator and 14–18 from oral to aboral end. Secondary prisms in 2–4 layers. Animal nearly fills cavity of bowl.

Three loricæ: L., total, 88–100 (92.5); collar, 32–42 (38.7); bowl, 49–58 (53.9). D., oral, 32–37 (34.3); neck, 32–42 (31.4); bowl, 47–51 (48.6) μ.

At 17 stations, viz., at 1, 6, 9, and 1, respectively, in California and Mexican currents, Drift, and Galapagos Eddy; at 72–85 (79.2)°; 69 loricæ.

Codonellopsis turgida Kofoid and Campbell

Plate 4, fig. 8

Lorica short, very stout, with collar shorter than bowl; bowl very stout ovate, with short neck; aboral horn short, stout, conical; 2.30–2.42 o.d., or 1.75–1.77 d. bowl. Oral margin thin, entire, abruptly everted. Suboral funnel an inverted, concave, truncate cone (44–65°) 0.11–0.13 of collar. Collar subcylindrical, 0.28–0.32 t.l., or 0.68–0.78 o.d., a leiotropic spiral lamina deflected 1–2° from horizontal, with 7–16 turns, 1–3 in suboral funnel. Lamina thickened along ventral edge, protruding outwardly above suture, very concave outwardly, so that lateral contour of collar is deeply serrate. Turns 0.02–0.06 o.d. wide anteriorly, 0.02–0.08 near middle, and 0.06–0.13 posteriorly. Fenestræ lacking. Local irregularities in suture line, suggesting extraneous influences. Nuchal diameter 0.85–0.92 o.d. Bowl strikingly wide, 0.48 total length ,0.81–0.85 its diameter, or 1.12–1.20 o.d., divided into

short neck and widely distended ovoidal region below. Neck a truncate cone (29–37°) 0.13–0.18 length of bowl; posterior diameter of 1.14–1.27 o.d. Bowl proper distended ovoidal, 0.5 t.l., greatest diameter 1.33–1.44 o.d., or 0.57 t.l., at 0.54–0.59 t.l. from oral margin. Aboral horn a stout inverted cone (25–35°) 0.18–0.24 t.l., or 0.43–0.60 o.d. Tip bluntly rounded or subconical (60°), bent to one side, or irregular. Septum recessed. Wall of collar uniform; of bowl thicker, a uniform, faint tertiary meshwork of subregular polygonal fields, 28 across equator on one face and 35 from end to end. Tertiary fields crowded with a secondary mesh of smaller subpolygonal, uniform fields, 75 across equator, with 1–2 faint subpolygonal fenestræ in equatorial zone larger than tertiary areas. A thin hyaline sheet lines cavity of bowl. Tertiary areas in a single layer, secondary prisms in 2–5 layers.

Four loricæ: L., total, 136–143; collar, 40–45; bowl, 70–78; aboral horn, 20–26. D., oral, 60–70; neck, 53–55; bowl, 80–83μ.

At 6 stations, viz., at 2 and 4, respectively, in Mexican Current and Drift; at 72–84 (77)°; 7 loricæ.

IV. COXLIELLIDÆ Kofoid and Campbell emended

Petalotrichidæ, *partim*, K. and C., 1929, p. 202. (Only Metacylis included. For Petalotricha, Acanthostomella, and Craterella see Petalotrichidæ.)
Metacylineæ K. and C., 1929, p. 197.

Tintinnoinea with a spirally coiled band forming whole or only anterior part of lorica; oral margin not denticulate; collar lacking, or, if present, spiraled and never widely flaring above; wall hyaline, trilaminate or alveolar, uniform throughout, without blobs; 2 macronuclei; marine, eupelagic, or neritic in tropical to Arctic seas.

Resembles Codonellopsidæ in having a spiral lamina, but differs from that family in having wall uniform in texture throughout and spiraled throughout except in Metacylis. Has affinities in structure through Coxliella, with the spiraled species of Tintinnopsis. Evidently an offshoot of the Codonellidæ through Tintinnopsis by evolution of a distinctive wall structure of the trilaminate type. In Metacylis, the differentiation of wall structure of collar and bowl parallels that in the Codonellopsidæ.

Includes as here modified, 4 genera, viz., Coxliella (19 species), Climacocylis (6), Metacylis (12) and Helicostomella (5).

Divided into two subfamilies, Coxliellinæ and Metacylinæ, the former new and the latter earlier (Kofoid and Campbell, 1929) in-

cluded in the Petalotrichidæ because of hyaline trilaminate wall. We here transfer it to the Coxliellidæ because of suboral spiral lamina, which allies it with the Coxliellidæ more closely than does its hyaline wall with the Petalotrichidæ.

COXLIELLINÆ subfam. nov.

Coxliellidæ with spiral lamina continued to aboral end in species closed aborally; if open aborally it may or may not extend to aboral end. Includes Coxliella and Climacocylis. In Coxliella spiral lamina extends whole length of more or less elongated, aborally closed lorica, with well marked secondary wall structure. In Climacocylis spiral either limited to anterior end or extended through whole length of lorica, with open aboral end.

METACYLINÆ Kofoid and Campbell

Coxliellidæ with spiral lamina limited to suboral region; aboral end closed, prolonged in point or horn. Includes Helicostomella and Metacylis. In Helicostomella the lorica is elongated and the spiraled part is not set off from the non-spiraled by a change in diameter. In Metacylis the lorica is shorter and stouter and in two-thirds of its species collar, nuchal region, and bowl are differentiated by changes in diameter.

7. COXLIELLA Brandt emended Laackmann emended Jörgensen

Cytharocylis, Kofoid and Swezy, 1921, p. 262, *lapsus* for Cyttarocylis.

Coxliellinæ with lorica generally cylindrical anteriorly, tall goblet- or tube-shaped; oral margin entire or minutely ragged, never regularly denticulate; collar not differentiated; aboral end closed, hemispherical, or inverted conical; aboral horn differentiated in only a few species; wall trilaminate, with thin inner and outer lamellæ, and an intermediate layer of fine or coarse secondary prisms; whole lorica formed by a single leiotropic or dexiotropic [?] spiral lamina withs uperposed turns of variable width; marine, eupelagic, mainly in tropical seas. Type species *Coxliella laciniosa* (Bdt.) Bdt. from South Equatorial Current of Atlantic.

Continuous spiral lamina whole length of lorica distinguishes it from

all other genera, except from a few species in Climacocylis, such as *digitula* and *elongata*, and several species in Tintinnopsis, such as *tubulosoides, spiralis, cincta,* and *urniger,* in all of which a faint spiral structure traverses the whole lorica. Derivable from spiraled species of Tintinnopsis by a modification of the amorphous wall structure into the rigid trilaminate type.

Waveringly established by Brandt (1907) and later definitely recognized by Laackmann (1909). Jörgensen (1924, 1927) emended it by rigid definition, excluding all loricæ not fully spiraled, and establishing two subgenera, Protocochliella and Cochliella. This revision was accepted by us (1929) except that Coxliella was substituted for Cochliella on nomenclatural grounds. We added *cymatiocoides, declivis,* and *pelagica* as new species, transferred *Amphorella cochleata* Meunier (1910) to Coxliella, renaming it *meunieri,* and also included, in part by transfer, *calyptra, frigida, intermedia, longa* (raised from varietal to specific status), and *tubularis. C. oviformis* Hensen is a *nomen nudum.*

Includes 19 species, of which 6 are present in Expedition collections. Of the 19 species, 4 are new and 3 are present in Expedition collections. Subdivided by Jörgensen (1924) into 2 subgenera.

Subgenus COXLIELLA Kofoid and Campbell

Characterized by well developed lamina and strongly developed secondary prismatic structure. Type species *Coxliella laciniosa* from Gulf Stream. Includes 3 series as follows: — the *calyptra* series, including *calyptra* (may be a radiolarian), *pelagica, pseudannulata, declivis, laciniosa, longa,* and *decipiens;* the *meunieri* series, including *meunieri, tubularis, intermedia, cymatiocoides, frigida,* and *minor;* and the *fasciata* series, including *fasciata, fabricatrix,* and *helix.*

Subgenus PROTOCOCHLIELLA Jörgensen

Characterized by imperfectly developed laminæ; faint prismatic structure; from temperate seas. Type species *Coxliella ampla* from off Bergen, Norway.

Coxliella declivis Kofoid and Campbell

Plate 6, fig. 11

Lorica small, short, relatively slender, subconical, tapering to prominent, sharply pointed, obliquely asymmetrical aboral end; 1.83–1.89 o.d. Oral margin entire, somewhat rounded. Anterior 0.4 of lorica, except for bulging lamina, subcylindrical. Posterior 0.6 an inverted convex cone, changing from 40 to 60° aborally, with a minute, solid, oblique, rod-like tip. Wall in 9 leiotropic spiral turns, increasing in width (0.22–0.32 o.d.) aborally in anterior 0.8, narrowest orally (0.04) and aborally (0.16–0.09), and widest (0.32) on eighth turn. Turns slightly convex outwardly, or plane. Slope of spiral 10–14°. Suture a straight, thin line. Wall 0.04 o.d. in thickness, with exceedingly fine primary meshwork of subpolygonal fields in several layers between an inner and an outer hyaline membrane. Fenestræ lacking. Aboral tip solid. Animal not seen, but a lorica from Sta. 4697 had a subspheroidal cyst, 49 by 56μ, with 4 oval macronuclei.

One lorica: L., total, 110. D., oral, 58μ. Second lorica, obviously flattened: L., total 110. D., oral, 63μ, 12 turns.

At 3 stations, viz., at 2 and 1, respectively, in California Current and Easter Island Eddy; at 69–75 (71.1)°; 3 loricæ.

Coxliella fabricatrix sp. nov.

Plate 6, fig. 12

Lorica long, narrow, with elongated, tapering bowl, abruptly contracted to a tapering conical aboral horn; 3.4 o.d. Oral margin entire, thick, rounded, and not everted. Bowl 0.67 t.l. or 2.25 o.d., an inverted, truncate cone of 12° in upper 0.15 t.l., changing to 6° below for 0.54 t.l., with an aboral diameter of 0.6 o.d., then contracting aborally (45°) in 0.12 t.l. to 0.28 o.d. into the aboral horn, a long, narrow, inverted cone (12°), 0.35 t.l., or 1.12 o.d., with blunt, closed tip. Wall in 20 leiotropic spiral turns, in suboral region 0.11 o.d. in width, gradually increasing through the thirteenth turn, then abruptly to 0.30–0.35 in the last 7 turns. Slope of spiral in anterior region 7–10°, becoming rapidly steeper up to 45° in base of aboral horn, continuing thus to end. Wall of large, secondary polygonal prisms, 35 across one face in middle of seventh turn, and about 25 below. An unusually thick inner, and an outer hyaline membrane encloses the prisms in 2–4 layers in

suboral section, 1–2 in long tapering section, and only 1 in lower bowl and aboral horn.

Two loricæ: L., total, 210–257; aboral horn, 70. D., oral, 62–75μ.

At 3 stations, viz., at 1 each in Peruvian Current, Panamic Area, and Galapagos Eddy; at 68–80 (73.6)°; 3 loricæ.

Coxliella fasciata (Kofoid) Brandt

Coxliella pseudannulata, Reichenow, 1927, p. 65, fig. 81, 4a.

Lorica long, rather large, narrow, with tapering conical bowl contracting aborally, with feebly differentiated aboral horn, blunt tip, 4.5 o.d. Oral margin thick, flaring slightly in marginal turn of spiral lamina, irregularly emarginate, or wavy. Bowl long, 0.65 t.l., or 2.96 o.d., an inverted, truncate cone (6°). Sometimes subdivided into two sections. Aboral horn an inverted cone (12°), 0.22 t.l., or 1.0 o.d., 0.3 of its length in diameter at proximal end, decreasing irregularly to a bluntly rounded, closed aboral end. Wall in 9 spiral turns of variable width, 0.3 o.d. in first two and last turns, 0.5 in third, 0.6 in fourth and seventh, 0.7 in fifth and sixth, and 0.45 in eighth, respectively. Turns concave or narrowly sigmoid in lateral contour. Slope steepest (15–45 [37])° in posterior turns. Suture a dark, thin, wavy line. Wall of large, subregular, subuniform, polygonal secondary fields, 25–35 across one face at middle of bowl, with little or no difference in size at ends of lorica, filled with tiny primary prisms. Very thin, hyaline, uniform inner and outer membranes enclose the single layer of secondary polygons.

L., total, 203; aboral horn, 60. D., oral, 45μ. As pointed out by Jörgensen (1924, p. 75), the measurements given by Kofoid (1905, p. 299) for this species are not in agreement with the designated magnification. As corrected upon Kofoid's original drawings, they are: L., total, 273; aboral horn, 75. D., oral, 53μ. No ground is left, therefore, for Brandt's distinction of his "variety *procera*," which was based upon dimensions.

At Sta. 4665 in Peruvian Current; at 68°; 1 lorica.

Coxliella laciniosa (Brandt) Brandt
emended Kofoid and Campbell

Lorica small, short and stout, goblet-shaped, subconical anteriorly, contracting abruptly to small, asymmetrical aboral point; 1.29–1.78 (1.57) o.d. Oral margin entire, thin, and erect. Lorica contracts evenly

in anterior 0.5, gradually increasing posteriorly, in a convex inverted cone changing from 7–65° in anterior 0.7 to 85–96° above aboral horn. Aboral end with very short, acute, asymmetrically curved, rod-like point, 0.25 o.d. in length, with blunt, closed tip. Wall in 6–9 (7.1) leiotropic spiral turns, increasing in width from 0.06 o.d. at oral to 0.4 o.d. towards aboral end. Individual turns vary in convexity among themselves and in different loricæ, being in some even concave outwardly. Slope of lamina 2–14°, steepest turns being widest, and the flattest those at oral end. Suture a dark, straight line. Wall made of a fine network of secondary subpolygonal prisms in 1–5 layers between inner and outer thin prismatic membranes. No fenestræ. Wall thin, 0.03–0.07 o.d. at middle, thicker near aboral horn. Lumen enters horn as a canal closed at tip.

Ten loricæ: L., total, 58–105 (79.2). D., oral, 47–65 (54.1)μ.

At 28 stations, viz., at 1, 2, 4, 2, 1, 1, 1, and 16, respectively, in California, Mexican, Peruvian, and South Equatorial currents, Panamic Area, Easter Island and Galapagos eddies, and Drift; at 67–85 (74.3)°; 104 loricæ.

Coxliella longa (Brandt) Laackmann

Lorica elongate, bullet- or tall goblet-shaped, subcylindrical anteriorly, contracting abruptly to very short, pointed aboral horn; 1.75–2.19 (1.94) o.d. Oral margin entire, wavy, or irregularly denticulate with few conical teeth, or rounded, not peripherally thickened, and erect, or a trifle everted. Lorica subcylindrical in anterior 0.43–0.54 (0.49) t.l., contracting thence aborally in a convex inverted cone changing from 21° below middle to 75° at aboral end. Aboral horn short, subcentral, asymmetrical, highly variable, a slender aciculate point, a bluntly rounded, obliquely truncate knob, a scarcely differentiated acute point, or asymmetrically rounded, even ragged and irregular, without any horn, with a canal through tip in one lorica only. Wall in 7–14 (10.0) leiotropic spiral turns of increasing width from oral to aboral end, 0.06–0.16 o.d. in width in oral 2–6 turns, and as much as 0.66 in widest one near lower end. Turns vary in degree of convexity, some even being concave. Slope of spiral 5–17°, steepest turns being widest. Suture an optically dark line. Wall made up of fine primary prisms in 1–3 layers between unusually thick inner and outer areolated membranes. Two loricæ had fenestræ, one numerous small elliptical areas in aboral 0.35; and scattered ones of irregular

form in oral region, the other at same station (4734) having only a few small fenestræ in aboral region. The first also had an *internal* hemispherical boss of a structure similar to that found in some species of Codonellopsis. Wall subuniform in thickness, 0.04 o.d. Animal relatively very small, attached at side on 7th turn of spiral lamina.

Six loricæ: L., total, 105–130 (116.6). D., oral, 56–65 (60.0)μ.

At 7 stations, viz., at 2 and 5, respectively, in California Current and Drift; at 69–80 (77.0)°; 8 loricæ.

Coxliella pelagica Kofoid and Campbell

Plate 6, fig. 16

Lorica very small, short bullet-shaped, tapering below middle to blunt aboral end, lacking an aboral horn; 1.81 o.d. Oral margin entire and rounded. Lorica outwardly convex above, widest part 1.12 o.d. at 0.28 t.l. from oral margin, a convex inverted cone below, changing from 18 to 52°, with a bluntly rounded undifferentiated aboral end. Wall in 9 leiotropic spiral turns, varying in width from 0.24 to 0.36 o.d. in the third to the eighth, and narrower at oral (0.4–0.8) and aboral (0.2) ends. Turns outwardly convex. Slope of spiral 31–13°, steepest in anterior 4 turns. Suture a thin distinct line. Wall very hyaline. This is the smallest species of genus, and might easily escape through mesh of No. 25 silk net.

L., total, 76. D., oral, 42μ.

At Sta. 4711 in Drift; at 75°; 1 lorica.

8. CLIMACOCYLIS Jörgensen
emended Kofoid and Campbell

Coxliellinæ with very delicate, flaccid, translucent, tubular lorica; oral margin entire; spiral band extending throughout, or in at least upper 0.33 of lorica; spiral shelf projecting horizontally from middle of band, except in *sipho*; aboral end with or without skirt, usually widely open with irregular margin; wall trilaminate, enclosing very large secondary prisms, of utmost transparency and delicacy of structure; marine, eupelagic preeminently in tropical seas. Type species *Climacocylis scalaria* (Bdt.) Jörg. from off Ralum (Brandt, pl. 26, fig. 4).

Stands wholly apart from all other genera in flaccidity, transparency, delicacy of wall, and lawlessness of aboral region; however, it resembles

other Coxliellidæ in basic wall pattern and spiral structure, but differs from all in spiral shelf.

Spiral shelf of Climacocylis is similar in lateral projection, slope, spacing, and extent on bowl, except that it does not reach the anterior end, to the spiral shelf of *Xystonella scandens*, which is limited to middle zone of bowl. *X. scandens* differs in that its wall shows no spiral lamina or suture. The occurrence of these structures in two genera otherwise so widely separated in pattern of lorica and wall structure can only be interpreted as a result of the basic relation of the spiraling movement of the animal to the formation and structure of the lorica.

Established by Jörgensen (1924) to include only *scalaria*, which had been assigned by Brandt (1907) both to Cyttarocylis and Coxliella. Kofoid and Campbell (1929) added four species, emending the genus to include species with no shelf and also those with only a partial spiral.

Includes 6 species, all in the Expedition collections. Of the 6, 4 were new (K. and C., 1929), and *leiospiralis* is described in this Report. Subdivided into two subgenera.

PROCLIMACOCYLIS subgen. nov.

Characterized by tapering lorica with spiral band limited to not over anterior 0.65; no lateral shelf; aboral end not enlarged; wall with fine secondary structure and occasional fenestra-like areas. Type and only species *Climacocylis sipho* (Brandt) (pl. 32, fig. 8; pl. 33, fig. 5) from Sargasso Sea.

CLIMACOCYLIS subgen. nov.

Characterized by more cylindrical lorica; spiral band forming anterior 0.5 or whole of lorica; projecting laterally in a spiral rounded ridge or angular shelf; aboral end sometimes irregularly enlarged; wall with coarse secondary structure and no fenestrations. Type species is that of genus. Contains 5 species: — *scalaroides*, *digitula*, *scalaria*, *elongata*, and *leiospiralis*.

Climacocylis digitula Kofoid and Campbell

Plate 6, figs. 6, 13, 14, 15

Lorica rather short, finger-shaped, tapering tubular, spirally laminate throughout, bearing on few turns a low, horizontal ridge fading out posteriorly, with open aboral end, 3.9 o.d. Oral margin entire,

regular. Oral diameter 0.8 widest spiral ridge, or 1.40 d. aboral end. Shaft subcylindrical throughout, an inverted, truncate cone (5°). Aboral end squarely truncate, 0.7 o.d., with irregular, undulating margin. Wall entirely made up of leiotropic spiral lamina of 15 turns of variable width, the upper 7 narrowest, 0.04–0.24 o.d. in width, the lower 8, 0.19–0.52, not uniformly increasing in width, but tending to become wider posteriorly, and those without ridges widest, 0.20–0.52. Slope in first 10 turns 3–5°, in last 5 much steeper (16–22°). Suture marked by darker line. Spiral ridge central on lamina, projecting, similar in location and formation to better defined one of *scalaroides*, but feebly developed in width and extent; widest on ninth and tenth turns, 1.13 and 1.15 o.d., respectively, elsewhere much smaller, fading out locally in irregular fashion, and disappearing entirely below tenth turn. Ridge obtusely subtriangular (90°), with base across whole lamina, height 0.6 of base, with rim more rounded toward aboral end. Wall exceedingly transparent, delicate, and flaccid; made up of subregular, subuniform secondary prisms, 25 across one face in suboral region, and 50–55 from end to end; larger aborally, with only 11 across one face in last turn. Superposed prisms form ridge. Wall 0.09 o.d. in thickness, increasing to 0.12 on widest ridges, made up of single layer of secondary prisms, except in ridges of anterior 10 turns, containing 2–3 layers.

L., total, 145. D., oral, 37; widest spiral ridge, 42 μ.

At Sta. 4583 in California Current; at 85°; 2 loricæ.

Climacocylis elongata Kofoid and Campbell

Plate 6, fig. 4

Lorica an elongated tube, tapering subcylindrical, with well developed spiral ridge fading out in last 3 turns, and open, not expanded aboral end; 6.12 o.d. Oral margin entire, regular, and without flare. Oral diameter 0.73 widest spiral shelf, or 1.19 d. aboral end. Shaft subcylindrical throughout, an inverted, truncate cone (4°), with minor changes in contour; spirally laminate throughout, formed of 17 leiotropic turns, locally irregular in width, increasing from 0.16 o.d. at oral end to 0.31 at third turn, 0.48 at ninth, and abruptly to a maximum of 0.58 in last 2 or 3 turns. Slope 5–15° from horizontal, increasing to 30° in last 2 aboral turns. Suture slightly undulating. Ridge extending from oral margin to next to last turn, a centrally located, outwardly projecting, horizontal, angled structure on lamina, but rapidly fading

out on third turn from posterior end; subtriangular in optical section (30–90°), with base formed by lamina. Outer edge of ridge broadly rounded, 0.08 o.d. in thickness, subject locally to bifurcation (Brandt, pl. 27, fig. 1), reduction, and irregularities. Widest transdiameters (1.4 o.d.) on shelf are in second three and antepenultimate three turns, the others ranging from 1.12 to 1.36, the first narrowest and most others near 1.24. Aboral end open, obliquely (30° from horizontal) truncate, not expanded, recurved, or thickened. Wall remarkably hyaline, almost invisible because of its great transparency, and therefore easily overlooked in a well illuminated microscopical field; very soft and flaccid, yielding to slightest pressure; made up of regular polyhedral secondary prisms, in one layer in margins of lamina, except in the 5 suboral turns where there are 2–3 layers, but increasing to 3 in the ridge aborally, and to 6 suborally; largest in aboral turns without ridge, in which prisms of unusual size occur locally; 56 across one face in suboral region, and 23 in aboral region. No primary structure detected either by Brandt (1906) or by us.

L., total, 355; posterior part without ridge, 45. D., oral, 58; widest ledge, 80μ.

At Sta. 4571 in California Current; at 71°; 1 lorica.

Climacocylis leiospiralis sp. nov.

Plate 6, fig. 3

Lorica large, exceedingly transparent, delicate, stout cornucopia-shaped, with spiral lamina continuous throughout to closed end; 5.83 o.d. Oral margin entire, regular, somewhat rounded. Oral diameter 0.17 t.l., or 0.82 d. on widest and lowermost prominent ridge. Lorica divided by changes in lateral contour into 3 regions; anterior a cylinder 0.55 t.l., or 2.16 o.d., with ledge; second a short inverted cone (12°) 0.23 t.l., with ledge; third an inverted truncate cone (40°) 0.22 t.l., lacking ledge except where it abruptly tapers off. Aboral end closed, bluntly pointed, and slightly asymmetrical. Entire wall of leiotropic spiral lamina of 13 turns of variable width; first 4 narrowest (0.09–0.16 o.d.), others 0.14–0.30 o.d., but not increasing uniformly, eighth, tenth, thirteenth, and fourteenth widest. Slope from 7 to 15° with no correlation between level or width. Suture marked by dark line. Ridge centrally placed on lamina, projecting; varying in width measured obliquely across lorica from 0.84 to 1.30 o.d., and measured across shelf only, from 0.04 to 0.24 o.d.; narrowest (0.04) in anterior 4 turns, and

widest (0.24) on fourteenth turn. Ridge with obtuse rounded rim in optical section, rim deflected downward in oral half of lorica and upward in aboral. Wall very translucent, delicate, and flaccid, made up of regular, uniform secondary prisms, only slightly larger toward aboral end, in one layer except across shelves, where there are up to 6 layers. Wall 0.07–0.09 o.d. in thickness, except across ridges (0.14–0.30) and in aboral region (0.11).

L., total, 350. D., oral, 60μ.

At Sta. 4732 in Drift; at 79°; 1 lorica.

Climacocylis scalaria (Brandt) Jörgensen

Climacocylix scalaria, Jörgensen, 1924, p. 77, fig. 81 (*lapsus pennæ*).

Lorica large, very transparent and delicate, anteriorly elongate cylindrical, with spiral lamina bearing on its middle a wide ridge, or shelf, and with aboral end expanded into a skirt of lobed, irregular, or conical form; 3.40–6.10 (4.65) o.d. Form of lorica is so irregular and variable that no one description is generally applicable, nor does it seem possible to subdivide the material in such a way as to facilitate description. Oral margin entire, very regular, sometimes oblique, never everted. Oral diameter 0.59–0.86 (0.73) of widest and usually most posterior spiral shelf. Anterior section, measured on shelf, a segment of an inverted truncate cone (2–4°) 0.55–0.75 (0.66) t.l., or 3.66–6.05 (4.79) o.d.; subdivided into 2 regions, an anterior section with shelf, and a posterior without one. Anterior section longer, 1.6–3.0 (2.4) o.d., or 0.45–0.65 (0.52) t.l., with spiral lamina of 5–11 (7.7) leiotropic turns. Lamina narrower in 1 or 2 suboral turns, widest in posterior 1 or 2, and subuniformly graduated between, disappearing with abrupt cessation of spiral ridge; width 0.13–0.50 o.d. Suture often irregularly serrate. Ridge, expanding into a veritable spiral shelf aborally, a highly characteristic feature of this species, extending horizontally from center line of lamina, triangular or rounded in optical section, generally thick, as much as 0.13 o.d., fairly uniform, except near oral margin; slope from 3 to 15 (8)° from horizontal, increasing posteriorly. Shelf wide, diameter on widest turn, always most posterior, 1.17–1.67 (1.37) o.d. Shelf subject to local irregularities in direction, thickness, slope, and dimensions, and even to suppression and bifurcation. Shelf-free section tubular, extending below spiral shelf 1–2 o.d., or 0.06–0.20 t.l., its diameter the same as oral, but its contour irregular, in some loricæ cylindrical, in others twisted, or differing in slope and angle on 2 sides,

or an inverted truncate cone (23°), never lacking, although differing in many features in different loricæ. Skirt 1.6–3.3 (2.2) o.d., or 0.35–0.55 (0.48) t.l., a region of greatest diversity in shape and lawless incoherence unusual among loricæ of pelagic Tintinnoinea. In some loricæ an expanded skirt open aborally, with an irregular aboral margin, subdivided into truncate conical (27°) neck 0.45 length of skirt and 1.26 o.d. posteriorly, and wider truncate cone (90°) with wide sigmoid contour; or a more or less asymmetrically twisted cone (22–30°) with irregularly convex sides, and often with subterminal asymmetrical lobe; or a subrectangular box-like expansion; or with 2–3 subvertical wings, or fins, of irregular form on aboral region, 2–3 o.d. in width and 2.0–2.5 in length. Aboral end closed, especially in loricæ with subconical tapering end, or open on end or side. Wall remarkably hyaline, delicate, very flaccid, and therefore easily overlooked in a brightly illuminated microscopical field. Secondary fields very prominent, fairly uniform and regularly polygonal, 20–30 across one face of cylindrical part, with 5 or 6 faint primary prisms within each; increasing regularly in size from oral to aboral end, although subject to irregularity, interruption, and intercalation of areas of smaller fields. This decrease in size of prisms from first- to last-made end of lorica is suggestive of fatigue, dilution, or slowing down in extrusion of substance which expands into prisms on contact with water, such as might occur as a progressive diminution in size of granules ejected from mouth of anterior daughter at fission and formation of a new lorica. Wall made up of a single layer of secondary prisms, except for 2–3 layers at aboral end and 5–8 layers in spiral shelf, 0.08 o.d. in thickness uniformly in anteriorly cylinder, except across spiral shelf (0.24) and in posterior cone (0.16). Animal with 2 large oval macronuclei, 8 by 12μ, 20 membranelles, and numerous food bodies, such as diatoms, and in one instance a small Protorhabdonella; fairly large, filling half of cylinder.

Ten loricæ: L., total, 170–340 (250); to end of spiral, 90–175 (130); skirt, 80–185 (120). D., oral, 50–63 (55); widest spiral, 58–100 (75.4)μ.

Our loricæ are generally of a small, aborally asymmetrical form, more like those of Laackmann (1913, pl. 5, fig. 65) and Jörgensen (1924, fig. 88) than of Brandt (pl. 21, fig. 15; pl. 26, figs. 4–6; pl. 27, figs. 2–3), but all types appear in our material, with the exception of a coccolith-bearing form figured by Brandt (pl. 26, fig. 5). Larger loricæ (330–340μ) were taken in colder waters of Peruvian Current at 67–69°, smaller ones (220μ) at 75°, and a considerable range (170–270μ) in length at the warmest stations (83°).

At 59 stations, viz., at 4, 7, 10, 3, 2, 1, 2, 3, 2, and 25, respectively,

in California, Mexican, Peruvian, South Equatorial, Equatorial Counter, and North Equatorial currents, Panamic Area, Easter Island and Galapagos eddies, and Drift; at 67–84 (75.5)°; 321 loricæ.

Climacocylis scalaroides Kofoid and Campbell

Plate 6, figs. 1, 10

Lorica small, stout, cornucopia-shaped, exceedingly transparent and delicate in texture, with spiral lamina restricted to anterior half or less, some turns bearing low, bluntly rounded median outer ridge, posterior region tapering, and aboral end asymmetrical and irregular; 3.42–3.94 (3.60) o.d. Oral margin entire, very regular, rounded, not everted or incurved; diameter 0.77–0.90 (0.84) d. of widest spiral ridge. Lorica formed of two regions, an anterior subcylindrical and a posterior tapering one. Anterior section 0.29–0.42 (0.34) t.l., or 1.00–1.44 (1.25) o.d., with uniform internal diameter formed by the spiral lamina with 4–7 (5.66) leiotropic turns, in varying widths, changing from 0.10 o.d. in narrowest (often most anterior) turn to 0.35 in widest (usually most posterior) turn, intervening ones subuniformly graduated between these extremes, with slope changing from 5 to 12° from oral to aboral end. Suture always smooth. Two to 5 of uppermost turns bear a wide, low, angular to broadly rounded, somewhat unevenly developed, projecting ridge, widest on first or second turn, not exceeding 1.11–1.30 (1.16) o.d., and declining below, projecting not more than 0.5 width of lamina, which forms base of rounded ridge. Ridge-free aboral section 0.58–0.71 (0.66) t.l., or 1.97–2.61 (2.25) o.d., subject to similar but not so extensive morphological irregularities as in *scalaria*, an inverted, asymmetrically, irregularly truncated cone (6–14°), with irregularities in contour, with upper diameter 0.98–1.00 o.d., and lower 0.3–0.5 o.d. Aboral end irregular, twisted, oblique, terminating in deformed aboral aperture with wall locally thickened or with ragged prolongations. Wall extremely delicate, flaccid, and of even greater transparency than in *scalaria*, hence has probably often escaped detection; made up of subregular polyhedral secondary prisms, 13–16 across one face of conical section and 17–22 across spiral region. Prisms uniform in size and shape at any given level, but progressively larger from oral to aboral end, being twice as large at posterior as at anterior. Primary structure within them not detected. One layer of secondary prisms in ridgeless wall, 2–3 in ridges, and 4 in thickened aboral region. Sutures visible as heavier lines resembling in optical section the inner and outer

lamellæ. Wall irregular in thickness, 0.06 o.d. in thinnest part of cone, 0.12 across widest spiral turn, 0.08 in others, and 0.30 in thick blob of aboral mass.

Three loricæ: L., total, 104–116 (110); spiral section, 30–49 (38.6). D., oral, 28–34 (32); widest ridge, 31–39 (39.6)μ.

At 6 stations, viz., at 1, 1, 3, and 1, respectively, in California and North Equatorial currents, Panamic Area, and Drift; at 75–83 (79.3)°; 9 loricæ.

Climacocylis sipho (Brandt) Kofoid and Campbell

Plate 6, fig. 2

Lorica a long, tapering tube, with well developed narrow spiral lamina in anterior section, and irregular, open, unexpanded aboral end; 7.1 o.d. Oral margin entire, regular, without flare. Oral diameter 1.62 d. aboral end. Shaft a narrow, inverted, truncate cone (4°), with minor irregularities of contour, in part with spiral lamina. Spiraled part of shaft 0.57 t.l., or 4.0 o.d., formed by 33 leiotropic turns, subequal within each of 4 sections of shaft, viz., anterior of 12 turns 0.08 o.d. in width; the middle of 14 usually less than 0.05, the next 5 about 0.06, and the posterior 2 expanding to 0.28. Slopes 4–9° from horizontal, last 3 turns steepest. Outer face of lamina concave, and very regular, smooth suture line clearly evident. Spiral shelf lacking. Posterior 0.43 t.l. of shaft wholly lacking spiral suture, an inverted, irregular truncate cone (5°) 0.94 o.d. at its upper end. Aboral end open, obliquely truncated at 89° from horizontal, with irregular broken margin. Wall flaccid, transparent, uniformly thin, 0.06 o.d., except in non-spiral section, where it thickens slightly; made up of single layer of very small, subregular, subuniform secondary prisms between inner and outer hyaline membranes, 50 across one face at middle of shaft, smaller suborally and larger aborally, where there are 20 across one face, and still finer primary prisms within each, very faint in suboral region and only 0.2 of their diameter in aboral. Fenestræ-like areas scattered or irregularly grouped, circular or elliptical in form, interspersed on wall. Animal (Brandt, pl. 32, fig. 8) very small, body length only 0.82 o.d., inverted, conical, with 9 membranelles on one side, and 2 ovoidal macronuclei, 9 by 12μ.

L., total, 355; laminate section, 200. D., oral, 50; aboral, 31μ.

At Sta. 4583 in California Current; at 83°; 1 lorica.

9. METACYLIS Jörgensen

Metacylinæ with short, wide, cylindrical, ovoidal to slightly elongate, or capsule-shaped lorica divided into collar and bowl; oral margin entire; circumoral region without lip, gutter, or thickened structure; collar spiraled, with 2–8, exceptionally 12, narrow, equal turns (or annuli?); bowl tubular or expanded; aboral end hemispherical, rounded, or acute, rarely with a projecting point, or very short aboral horn; aboral end closed; wall trilaminate, similar in collar and bowl, with inner and outer lamellæ, and at most simple prismatic intermediate layer; marine, eupelagic from polar to tropical seas. Type species *Metacylis mediterranea* (Mereschkowsky) Jörgensen emended, from Mediterranean off Naples.

Established by Jörgensen (1924) for *mediterranea,* and its var. *pontica.* We (1929) enlarged and redefined the genus and added 10 species, 3 new ones from Expedition collections, and 7 previously and variously allocated to Tintinnus, Cyttarocylis, Codonella, Amphorella, and Ptychocylis by Ostenfeld and Schmidt (1901), Cleve (1902a), Brandt (1907), Fauré-Fremiet (1908a), and Meunier (1910, 1919). One species, *jörgensenii,* had been allocated in literature to all 5 of the above named genera, and under 6 different specific or subordinate designations (see K. and C., 1929, p. 199).

Singularly isolated in appearance and seemingly unrelated to other genera. However, the basic plan of wall structure and the basic pattern of lorica clearly place it in the Coxliellidæ. Coiled collar suggests Helicostomella and Climacocylis, but Metacylis lacks large secondary wall structure of latter and narrow elongate form of former. Aboral end little developed and very regular, unlike the lawless one of Climacocylis or the long pedicellate one of Helicostomella. Small size, simple wall structure, and regular symmetry of lorica suggest affinity to Craterella, but Craterella lacks collar, and has a circumoral structure like that of Acanthostomella, elsewhere rare in the Tintinnoinea. Metacylis presents some features that suggest Petalotricha, such as the shape, but differs from it in wall structure and spiral (or annular) collar not subdivided into 3 sections as in Petalotricha. Metacylis suggests the Undellidæ in its shape of loricæ and hyaline wall, but differs in the sharply defined spiral or annular collar.

Includes 12 species, of which 3 were recorded in Expedition collections. Of the 12, 4 were new and 2 given new names. Of the 4, 3 occur in Expedition collections. Subdivided into two series: — the *conica* series, including *conica, annulifera, annulata, lucasensis,* and *vitreoides,*

and the *corbula* series, including *corbula, mereschkowskii, jörgensenii, macedonica, pontica, mediterranea,* and *rossica.* The small size permits loss through the mesh of the silk net.

The form described as *Favella Ehrenberg* var. *Macedonica* by Athanassopoulos (1930, p. 473, fig. 2, labelled as Fig. I) belongs to this genus by reason of its annular or spiral (?) collar.

Metacylis conica Kofoid and Campbell

Plate 6, fig. 7

Lorica very minute, slender, with collar of 6 turns [?], bowl with slightly rounded shoulder, and long conical aboral end; 2.63 o.d. Oral margin entire. Oral opening 0.38 t.l. Collar an inverted, truncate segment of a cone (15°), 0.24 t.l., or 0.58 o.d., made up of 6 slightly deflected, subequal turns of spiral lamina 0.1 o.d. in width. Nuchal diameter 0.83 o.d. Bowl 0.76 total length, or 2.06 o.d., unequally biconical. Anterior cone (36°) truncated, 0.1 t.l., or 0.25 o.d., widest part (1 o.d.) of bowl, at 0.33 t.l. from oral margin. Lower section an inverted cone (30°). Aboral end bluntly pointed. Wall uniformly hyaline throughout, very thin, without evident prismatic structure.

L., total, 45; collar 10. D., oral, 17 μ.

At Sta. 4580 in California Current; at 76°; 1 lorica.

Metacylis corbula Kofoid and Campbell

Plate 6, fig. 5

Lorica small, very stout, with contracting collar with 4 rings or turns (?), a basket-shaped bowl with rounded shoulder, and no aboral point; 1.33–1.46 (1.41) o.d. Oral margin entire. Collar thin-walled, short, stout, suberect above, flaring below, 0.21 t.l., or 0.30 o.d. Oral diameter 0.68–0.74 (0.71) t.l., or 0.86–0.95 (0.90) length of bowl. Upper part of collar a truncate segment of a cone (12–18°), 0.5 of collar; lower part a truncate segment of a wider cone (42–45°), with basal diameter 1.08 o.d. Collar made up of spiral lamina slightly deflected from horizontal, of 4 subequal turns, 0.07 o.d. in width. Bowl truncate ovoidal, 0.8 t.l., or 1.05–1.16 (1.11) o.d. In its anterior 0.25 a wide convex cone (35–40°), widest (1.12 o.d.) at shoulder, contracting aborally gradually (12–15°), and becoming broadly hemispherical in distal half. Aboral end without point. Wall of both collar and bowl hyaline, trilaminate,

without evident prismatic structure, uniformly 0.04 o.d. in thickness.

Two loricæ: L., total, 50–54; collar, 11; bowl ,40. D., oral, 37; bowl, 44μ.

At anchorage at Panama Harbor and off Taboguilla Island; at 80 and 83°; abundant.

Metacylis lucasensis Kofoid and Campbell

Plate 6, fig. 9

Lorica small, stout, thimble-shaped with collar of 4 rings, or turns (?), and hemispherical aboral end; 1.68 o.d. Oral margin entire. Collar thin, erect. Diameter of oral opening 0.6 t.l. Collar 0.33 t.l., or 0.54 o.d., made up of 4 subequal, convex, slightly deflected turns 0.14 o.d. in width. Bowl inverted thimble-shaped, 0.67 t.l., or 1.17 o.d.; upper part subcylindrical, 0.44 t.l., or 0.78 o.d.; lower part hemispherical. Aboral end without point. Wall hyaline throughout, very thin, uniformly bilaminate, with no evident prismatic structure.

L., total, 47; collar, 15. D., oral, 28μ.

At Sta. 4583 in California Current; at 83°; 1 lorica.

10. HELICOSTOMELLA Jörgensen emended Kofoid and Campbell

Metacylinæ with lorica elongate, pencil-shaped; oral rim entire; suboral region cylindrical, formed by spiral band of 3–60 turns; aboral region inverted conical, not spiraled, aboral horn pointed, elongate, or aciculate; wall thin with fine primary mesh between two lamellæ; marine, eupelagic, and neritic in temperate seas. Type species *Helicostomella subulata* (Ehrenberg) Jörgensen, described by Ehrenberg (1833, 1838) from Baltic, off Kiel.

General pattern not unlike that of Metacylis, but the latter differs in having a very fine prismatic structure, and in tending to be stouter, to have fewer rings, and an aboral horn in one species only (*M. rossica*). Its spiral hyaline collar is comparable to that of the Codonellopsidæ, and especially of Laackmanniella, but the genus differs from that family in wall structure, and from Laackmanniella in aboral horn. Helicostomella is close to Laackmanniella and might well have been derived from it. The short and stout *H. longa* is somewhat like *Metacylis rossica*, though nearer in size to the blunt-tipped *M. conica*. The genera Laack-

manniella, Metacylis, and Helicostomella are close in morphological pattern, but less so in wall structure.

Established by Jörgensen (1924, 1927) but included only *subulata*. We (1929) included 5 species and amplified the description of the genus.

Contains five species, *edentata*, *fusiformis*, *kiliensis*, *longa*, and *subulata*, of which only *longa* occurs in Expedition material.

Helicostomella longa (Brandt) Kofoid and Campbell

Plate 6, figs. 8, 17

Lorica very small, short, or somewhat elongated, bullet-shaped, with shorter subcylindrical anterior section with turns of a spiral lamina and longer posterior subconical non-spiralled division with an acute aboral point; 1.81–4.39 (2.75) o.d. Oral margin minutely, sometimes sparsely, and very irregularly denticulate, with a slight suboral constriction immediately below rim in some loricæ. Lorica with two regions, the upper a long subcylinder, 0.59–0.72 (0.65) t.l., or 1.80–4.25 (2.84) o.d., with local minor changes, or expanding gradually from oral margin posteriorly as segment of cone (5°) with aboral diameter of 1.07 o.d., sometimes with a lateral concavity at 0.5 o.d. below oral margin, with a minimum diameter 0.94 o.d. Lower section a conical or subconical region (32–70°), 0.30–0.41 (0.35) t.l., or 0.78–1.69 (1.02) o.d., decreasing with convex outlines throughout, or in proximal half with scarcely concave ones distally. Aboral end acute, rarely rounded. Ribs 4–8, very faint, in gently curved right spiral (20° from vertical), 0.22 t.l., terminating on pointed tip. Spiral lamina restricted to suboral 0.14–0.40 t.l., with 2-11 (6.0) narrow (0.06–0.16 o.d. in width), leiotropic, uniform turns. Slope 2° from horizontal. Suboral 2–3 turns often bear on upper edge numerous minute serrations like those on oral margin, but this edge is sometimes entire. Suture very distinct and dark, and lateral contour scarcely affected by spiral. Wall uniform, slightly irregular near aboral tip, composed of a highly refractive greenish substance constituting the thickened inner and outer laminæ, with faint traces of minute, subregular prismatic structure between the two laminæ. Animal large, filling most of lumen of upper part. Cytoplasm crowded with numerous food bodies, 2 oval macronuclei.

Nine loricæ: L., total, 38–85 (56.2). D., oral 19–23 (20.4) μ.

At 4 stations, viz., at 1, 2, and 1, respectively, in Mexican and Peruvian currents and Drift; at 67–82 (72.2)°; 13 loricæ.

V. CYTTAROCYLIDÆ Kofoid and Campbell emended

Cyttarocylidæ, *partim*, K. and C., 1929, p. 108 (see also Ptychocylidæ and Xystonellidæ).
Cyttarocylineæ K. and C., 1929, p. 108.

Tintinnoinea with inverted bell-shaped, kettle-shaped, or inverted subconical to elongated conical lorica; always with flaring collar set off by nuchal constriction; never with spiral lamina; wall with coarse secondary reticulation; 2 or more macronuclei and micronuclei; marine, eupelagic and tropical.

Only a single genus, Cyttarocylis Fol, with 11 species included. Founded by Kofoid and Campbell (1929) and subdivided into subfamilies Cyttarocylineæ and Favellineæ. In this Report genera formerly included in the Favellineæ are redistributed as follows: Cymatocylis, Protocymatocylis, Porœcus, and Favella are placed, together with Ptychocylis, in the family Ptychocylidæ, and Parafavella in the Xystonellidæ. These changes leave Cyttarocylis as type genus and only one in the Cyttarocylidæ.

The family as here defined differs from all others in type of reticulated wall structure, with reticulations markedly uniform in pattern throughout, with neither horizontal nor vertical arrangement, and no regional differentiations in pattern. Differences in size of mesh occur between species, and regionally. Another characteristic is the great thickness of the enclosing mesh of the reticulations. The areas enclosed resemble somewhat those of lower bowl of lorica of Epiplocylidæ, but in that family they are mainly limited to posterior end and always dominated by vertical lines of mesh. Furthermore, they are outwardly excavated, while in the Cyttarocylidæ the mesh lies between the inner and outer double-contoured laminæ of the wall. Resembles Parafavella (Xystonellidæ) in wall structure most closely, but differs from it in presence of collar.

All marine, in warmer tropical seas. Not recorded outside of tropics, except in Mediterranean or nearby.

11. CYTTAROCYLIS Fol emended Laackmann emended Jörgensen emended

Cyttarocylis, *partim*, K. and C., 1929, p. 109 (see also Codonopsis).

Cyttarocylidæ with large, subconical, acorn- or kettle-shaped lorica; oral margin entire, or feebly denticulate; collar flaring, a short, in-

verted, truncate cone; nuchal region marked by outer constriction and inner ledge with sharp edge; bowl convex-conical to bag-shaped; aboral end rounded, pointed, or obtuse, with or without pedicel-like extension, sometimes open posteriorly with a minute central canal; wall reticulated throughout with unequal, heavy-walled polygons, between outer and inner double-contoured lamellæ, each enclosing primary prisms; marine, eupelagic in warm temperate and tropical seas. Type species *Cyttarocylis cassis* (Hæckel) Fol from off Messina, as designated by Apstein (1915, p. 123).

With the removal of *Cytt. ollula* to our new genus, Codonopsis, Cyttarocylis becomes homogeneous and readily definable. As now constituted, it is remarkably isolated from all other Tintinnoinea except Parafavella in its distinctive type of wall structure. The sharply set-off flaring collar and undeveloped aboral horn distinguish it from Cymatocylis, Protocymatocylis, Favella, Parafavella, and Porœcus, which genera it remotely resembles. In its trilaminate wall, discrete and completely reticulated wall structure, tendency to oral denticulation, and aboral extension, it has close affinities with Parafavella, but differs from it in pattern of bowl, presence of collar, and less regularity in reticulation.

Established by Fol (1881, 1884) to include *cassis, cistellula, denticulata,* and *ehrenbergii.* Brandt (1907) extended it widely to include species now found in Climacocylis, Coxliella, Craterella, Favella, Parafavella, Porœcus, Tintinnopsis, Xystonella, and Xystonellopsis. Laackmann (1907) further extended it to include species now assigned to Cymatocylis and Protocymatocylis; and later (1909) partially restricted it to exclude the two genera Xystonella and Coxliella. Hæckel (1887) included *cucecryphalus* in Sethocephalus, a radiolarian (see Kofoid, 1912). Jörgensen (1924) soundly conceived the genus by restricting its content to species with the reticulated wall, which restriction we accepted (1929), adding to his two species, *cassis* and *cucecryphalus,* 12 others, by more rigid specific definitions, as well as new material.

In this Report we transfer *ollula* to Codonopsis gen.nov., leaving a still more homogeneous content of 11 species. *Cyttarocylis acuminata* (Ehrenberg, 1854b) Brandt, which we (1929, p. 109) quoted from Brandt (1907, p. 50) as an indeterminate Cyttarocylis (?), agrees in its description very closely with Parafavella. It was found in a collection from off Newfoundland. Its length was 1/36 of a Prussian line, or 60.5μ, and its diameter 1/48$'''$, or 45.4μ. It is nearest to *Parafavella groenlandica* in proportions and size. Brandt's (pl. 37, fig. 1) figure

which we (1929, p. 166, fig. 304) named *P. greenlandica* is 80 by 48μ, and thus well within the probable range in dimensions. *Cyttarocylis acuminata* Ehrbg. from off Newfoundland is therefore transferred to Parafavella, and *P. greenlandica* becomes a synonym of it. This removes a northern species from an otherwise tropical genus.

Includes 12 species, of which 9 are included in the Expedition collections. Of the 12, 6 were new; of the 6, 5 are in Expedition collections. *C. rotundata* Nordgaard (1899) is a *nomen nudum*, leaving 11 valid species. Subdivided into three series: — the *cucecryphalus* series including *eucecryphalus, brandti, ricta, longa,* and *plagiostoma;* the *obtusa* series including *obtusa* and *mucronata;* and the *cassis* series, including *cassis, conica, acutiformis,* and *magna.*

Cyttarocylis acutiformis Kofoid and Campbell

Non *Cyttarocylis cassis* forma *acuta* Jörgensen, 1924, p. 79 (see *C. cassis*).

Lorica very tall, elongated conical, with steep-sided collar, flaring little more than bowl; very long tapering bowl with a little change in slope distally near acutely pointed aboral end; 1.69–1.96 (1.75) o.d. Oral margin regular, thin, outwardly flaring, with 150 low, triangular, subequidistant, sharp or rounded teeth. Oral diameter 0.51–0.65 (0.57) t.l., 0.57–0.74 (0.64) length of bowl, or 1.09–1.24 (1.17) nuchal diameters. Collar set off by only a slight change in slope at angular nuchal constriction; an inverted, truncate segment of a cone (30–40°), 0.11 t.l., 0.13 length of bowl, or 0.17–0.21 (0.20) o.d.; sigmoidal in lateral outline, with greatest curvature in lower 0.25. Nuchal diameter 0.81–0.92 (0.85) o.d.; nuchal opening 0.73 o.d.; nuchal angle 160–165°; nuchal shelf triangular, upper surface horizontal. Bowl a very elongate, slightly convex, inverted cone (27–37°), 0.88–0.89 (0.88) t.l., 1.36–1.75 (1.55) o.d.; anteriorly 15–24° for up to 0.3–0.4 its length, widening to 45–60° distally; widest at nuchal constriction. Aboral region changing in contour from convex to concave, delimiting a short conical (35–40°) aboral section with a bluntish tip traversed by an axial canal. Wall with very small, rather irregular, uneven, sharp-angled secondary polygons of triangular to pentagonal pattern; smaller below oral margin and toward aboral end, where they are a half to a third the size of those across equator; 30–35 on one face across neck, 40–47 across middle of bowl, 70–80 from oral rim to aboral end, and in 4–6 rows of large, and several rows of minute ones in collar, in one layer throughout, except for 2 in nuchal shelf. Loricæ at Sta.

4722 and 4723 contained a coccolith of Coccolithophora in nearly every field. Each secondary mesh encloses 40–64 small hexagonal primary prisms in 3–5 layers. Animal fills half of lorica. *Acutiformis* is not the same as *cassis* forma *acuta* (Jörgensen, 1924, p. 79) which is only the acutely pointed form of *cassis*.

Six loricæ: L., total, 200–257 (228.6); collar, 24–30 (26); bowl, 176–227 (202.6). D., oral, 120–140 (130.1); nuchal 106–116 (111) μ.

At 35 stations, viz., at 3, 5, 4, 2, 3, and 18, respectively, in California, Mexican, Peruvian, and South Equatorial currents, Panamic Area, and Drift; at 67–85 (77.1)°; 107 loricæ.

Cyttarocylis brandti Kofoid and Campbell

Plate 7, fig. 8

Cyttarocylis plagiostoma, Hofker, 1931b, pp. 371–372.

Lorica rather small, stout, acorn-shaped, with widely flaring collar, short, wide bowl, and bluntly pointed aboral end; 0.87–0.98 (0.93) o.d. Oral margin minutely and subregularly serrate, with 56 low, rounded, subequal, equidistant, triangular teeth. Oral diameter 1.02–1.15 (1.08) t.l., 1.15–1.29 (1.21) lengths of bowl, or 1.09–1.16 (1.15) nuchal diameters. Collar a very short, convex, inverted segment of a cone (75°) 0.08–0.16 (0.11) t.l., or 0.07–0.15 (0.10) o. d., nuchal diameter 0.86–0.92 (0.88) o.d.; nuchal opening 0.76; nuchal angle 130°; and nuchal shelf inclined upward 45°, thinning down to a sharp edge, forming above a shallow trough at bottom of collar outside of nuchal rim. Bowl a very short, wide, acorn-shaped bag, 0.84–0.91 (0.89) total length, or 0.79–0.87 (0.83) o.d., widest (0.9 o.d.) at 0.4 t.l. from oral rim. Aboral region a little less than a hemisphere. Aboral end with a low, bluntly acuminate point about thickness of wall in length. Wall with unequal, triangular to hexagonal secondary polygons with rounded angles; larger above and below nuchal constriction, and smaller in aboral half of bowl; 30–35 across one face at widest part of bowl, 35–40 from oral to aboral end, and in 2–3 rows in collar; in a single layer, except for 2–3 in nuchal shelf. Each secondary polygon encloses 12–15 hexagonal primary prisms in 3 layers. Animal fills 0.7 of cavity. Hofker (1931b, figs. 51–53) finds 18 membranelles, and figures about 80 nuclei which he states are "vielleicht Zooxanthellæ", which may be, at least in part, siderophile granules of lorica-building substance formed in the cytoplasm prior to fission.

Ten loricæ: L., total, 90–96 (92.6); collar, 7–14 (9.8); bowl, 76–86 (82.8). D., oral, 94–106 (99.9); nuchal, 85–92 (87.6)μ.

At 25 stations, viz., at 4 and 21, respectively, in Easter Island Eddy and Drift; at 77–81 (75.8)°; 103 loricæ.

Cyttarocylis cassis (Hæckel) Fol

Cyttarocylis cassis var. *a*., Gräf, 1909, p. 142, fig. [3]c.
Tintinnus sp. Lindemann, 1924, p. 892, fig. 10.
Cyttarocylis cassis forma *acuta* Jörgensen, 1924, p. 79.
Cytharocylis cassis Hofker, 1931b, p. 315.

Lorica moderately large, elongated conical, with steep, flaring collar, convex, bullet-shaped bowl, pointed aboral end, and minute terminal stub; 1.59–1.84 (1.76) o.d. Oral margin wavy, minutely, sparsely, and irregularly beset with teeth. Oral diameter 0.54–0.59 (0.57) t.l., 0.62–0.68 (0.65) length of bowl, or 1.17–1.21 (1.20) nuchal diameters. Collar an inverted, truncate segment of a cone (53–54°), convex outwardly, 0.12 t.l., or 0.21 o.d., distinctly set off from bowl by deeply recessed nuchal constriction. Nuchal angle 130–150°; nuchal diameter 0.82–0.84 o.d.; and nuchal opening 0.75 o.d. Bowl a stout, convex cone (32°), 0.87 t.l., or 1.46–1.62 (1.54) o.d.; widest either at nuchal groove or a collar's length below. Aboral end conical (70°), acute, with a minute, blunt stub, whose length equals its basal diameter, perforated by a central axial canal. Wall with a meshwork of subregular, subpentagonal or subhexagonal, sharp-angled polygons, 20–30 across one face at neck, 18–29 across equator, 3–5 rows across collar, and 36–42 from neck to aboral end, distinctly larger in anterior 0.66 of bowl than aborally, where they are reduced to half or less. Hæckel figures (1873, pl. 26, figs. 1–3) animal with 20 membranelles, a circular peristome collar, a subconical cytosome extending well beyond oral rim, a ciliated embryo, and a spore. As suggested by Daday (1887b), the "embryo" may be a larval form of an associated suctorian. Hofker (1931b) reports 18–20 macronuclei.

Three loricæ: L., total, 202–205; collar, 24–26; bowl, 178–179. D., oral, 110–122μ.

We have not followed Brandt (1907) in recognizing a distinction between the form originally described by Hæckel (1873, pl. 27, figs. 1–3) and the former's var. *a* (pl. 34, figs. 1, 2, 4, 5). The only difference between the two is in dimensions. Hæckel's figures are obviously drawn with a free hand, but his Figure 1 and Brandt's Figure 5, plate 34, are remarkably alike in outline and proportions. Dimensions as

stated by Hæckel are: length, 110μ, oral diameter, 80μ, but they measure 120μ and 82μ. Should these figures have the same magnification (400) as some others on his plates, the length of his lorica would be 174μ and would agree with that of subsequent investigators of the species in Mediterranean waters. Otherwise, this species, as Brandt states (p. 195), is a rare dwarf form. No one has seen it since Hæckel.

The forma *acuta* proposed with neither figure nor description by Jörgensen (1924, p. 79) is a pointed form included by us (1929, p. 112) in *cassis;* it should not be confused with *C. acutiformis.*

At 10 stations, viz., at 2, 1, 2, and 5, respectively, in California and Peruvian currents, Easter Island Eddy, and Drift; at 69–83 (73.3)°; 14 loricæ.

Cyttarocylis conica Brandt

Lorica large, stout, conical bag-shaped, with steeply flaring collar, slightly convex, conical bowl, and flattened aboral end with minute, projecting central point; 1.60–1.93 (1.76) o.d. Oral margin thin, flaring, minutely and irregularly serrate. Oral diameter 0.52–0.62 (0.56) t.l., 0.57–0.70 (0.63) length of bowl, or 1.17–1.21 (1.19) nuchal diameters. Collar 0.1 t.l., or 0.17 o.d., a truncate, inverted segment of a cone (54–60°) with plane or slightly externally convex sides. Nuchal diameter 0.76–0.82 (0.81) o.d., nuchal opening 0.72–0.78 o.d., nuchal angle 155–160°, and nuchal shelf angular (90°) and slightly protruding. Bowl a moderately stout, convex, inverted segment of a cone (33–36°), 0.89–0.92 (0.9°) t.l., or 1.42–1.76 (1.59) o.d., anteriorly contracting (10–15°) gradually for 0.45–0.53 t.l., and to 50–60° posteriorly; widest at nuchal level. Aboral end almost squarely truncate, with rounded margin, 0.23 o.d. in diameter, with minute, central conical (60°) point or hemispherical boss, with basal diameter 0.2 truncate end. No axial canal in point. Wall with regular, coarse pentagonal secondary polygons with rounded angles; 50 across one face at neck, 35–40 across equator, 48 from end to end, and in 4 rows of subequal size in collar; larger at oral than aboral end of bowl, where their size is half that of suboral ones; in one layer throughout.

Two loricæ: L., total, 208–260; collar, 22–23; bowl, 185–238. D., oral, 130–135; flattened aboral end, 27–40μ.

At 2 stations, 1 each in Peruvian Current and Drift; at 68–72 (70)°; 2 loricæ. Type locality Sta. Pl. 67 in Atlantic North Equatorial Current (Brandt, pl. 34, fig. 6), not Sta. Pl. 17, as incorrectly cited by us (1929, p. 110).

Cyttarocylis eucecryphalus (Hæckel) Kofoid

Plate 7, fig. 2

Cyttarocylis plagiostroma [sic], Gräf, 1909, p. 140, fig. [2]f.

Non *Cyttarocylis eucecryphalus* [sic] Athanassopoulos, 1930, pp. 473–474, fig. 2 (see *Favella* for discussion).

Lorica very small, stout, bag-shaped, with low, widely flaring collar and aborally flattened bowl; 0.95–1.27 (1.09) o.d. Oral margin minutely denticulate, with 120 low, sometimes bifurcate, irregular serrations, or strongly denticulate, with 64 sharp, triangular, subequal, subequidistant teeth. Oral diameter 0.79–1.06 (0.91) t.l., 0.87–1.14 (1.01) length of bowl, or 1.01–1.12 (1.11) nuchal diameters. Collar a short, convex, widely flaring segment of an inverted cone (46–59°) 0.08–0.10 (0.09) t.l., or 0.09–0.16 (0.10) o.d. Nuchal angle 140°; nuchal diameter 0.89–0.91 (0.90) o.d.; nuchal opening 0.74–0.81 o.d.; nuchal shelf flattened above, obliquely tilted upward. Bowl a stout bag, convex inverted subconical, 0.89–0.92 (0.90) t.l., or 0.88–1.15 (0.99) o.d. Aboral end flattened, closed, with no aboral point. Wall with very small, subregular, triangular to hexagonal secondary polygons, with rounded angles and relatively wide beams. Polygons of the same size at all levels, except for a nuchal row or two of smaller ones; 20–25 across one face below neck, 18–22 across middle of bowl, 20–28 from neck to aboral end, and 2–3 rows in collar; in one layer except for 3 in nuchal shelf; each secondary polygon encloses 10–60 small hexagonal primary prisms in 5–12 layers. Animal fills 0.8 of cavity.

Ten loricæ: L., total, 106–142 (124); collar, 8–14 (11.8); bowl, 98–129 (112.2). D., oral, 111–116 (113.3); nuchal, 101–104 (102.4) μ.

At Sta. 4574 in a haul from 300–0 fms. 2 loricæ were found with mouths in apposition, adhering closely, though the plankton collections had been handled frequently and often examined. The protoplasmic contents were much reduced and gathered in one lorica, except for a small remnant in the other. The loricæ of the two conjugants differed in length (120 and 132 μ), and in proportions (0.98 and 1.10 o.d., respectively), and were smaller than all others (123–142 μ) at the same station except one (118 μ).

Differences in size of lorica are correlated with temperatures. Loricæ at Sta. 4574 (69°) range in length from 118 to 142 μ; at stations at higher temperatures (71–81°) the range is 106–125 μ. Larger loricæ (140–142 μ) found only in colder waters. Loricæ with large subnuchal lacunæ occur at Sta. 4590.

Hæckel (1887) in his "Challenger" monograph on the Radiolaria

describes (p. 1298) and figures (pl. 56, fig. 13) a typical lorica from the Pacific, calling it *Sethocephalus eucecryphalus*. The genus Sethocephalus was erected by him in 1887 to replace his Platycryphalus, proposed in his "Prodromus" (1881) for a "few and rare Sethocorida" which lacked the collar beams characteristic of other Sethocorida and had a "flat discoidal thorax like the brim of a hat." It is obvious, as shown elsewhere (Kofoid, 1912), that the "skeleton" figured by Hæckel is the lorica of this species, agreeing with it in structure, dimensions, and pattern of fields.

At 47 stations, viz., at 5, 3, 2, 1, 6, and 30, respectively, in California, Mexican, and Peruvian currents, Panamic Area, Easter Island Eddy, and Drift; at 67–84 (74.6)°; 264 loricæ.

Cyttarocylis longa Kofoid and Campbell

Lorica short, stout, acorn-shaped, with steeply flaring collar, baggy bowl, and obtusely pointed aboral end; 0.88–1.09 (1.01) o.d. Oral margin thin, somewhat upturned, minutely and subregularly serrate, with 160 very small, sometimes bifurcate, subequal, subequidistant, triangular teeth. Oral diameter 0.92–1.14 (0.99) t.l., 1.04–1.33 (1.14) nuchal diameters, or 1.04–1.27 (1.14) lengths of bowl. Collar a short section of an inverted truncate cone (49–63°), 0.09–0.13 (0.12) t.l., or 0.09–0.15 (0.14) o.d., with plane sides. Nuchal diameter 0.75–0.92 (0.91) o.d.; nuchal opening 0.8; and nuchal angle 135–150°. Bowl stout acorn-shaped, sharply set off, 0.86–0.91 (0.88) t.l., or 0.79–0.97 (0.88) o.d., widest either at nuchal groove or within 0.2 o.d. of that level, broadly ovate, contracting slowly in anterior 0.66, but abruptly in distal 0.33 to a subhemispherical contour. Aboral end obtusely pointed, but without projection. Wall with small but well defined, sharp-angled, triangular to hexagonal, secondary polygons, unequal in size, larger in upper half of bowl, and smaller (0.25–0.75 size of larger) on collar and lower half; 20–35 across one face of bowl and from end to end; 3–4 rows of very unequal ones in collar; and at all levels in one layer, even in nuchal shelf. Each secondary polygon encloses 10–60 subhexagonal primary prisms.

Ten loricæ: L., total, 95–115 (108); collar, 10–16 (12.8); bowl, 85–105 (95.2). D., oral, 100–113 (107.4); neck, 85–100 (94.2) μ.

At 46 stations, viz., at 3, 4, 13, 1, 5, 2, 2, and 16, respectively, in California, Mexican, Peruvian, and South Equatorial currents, Panamic Area, Easter Island and Galapagos eddies, and Drift; at 67–84 (70.9)°; 155 loricæ.

Cyttarocylis magna Brandt

Plate 7, fig. 6

Lorica very large and much elongated with very slightly flaring, scarcely emergent collar, very long, aborally more convex conical bowl, and aboral end with short, blunt, projecting diminutive horn; 2.18–2.36 (2.25) o.d. Oral margin thin, everted, with trabeculæ of polygons projecting as 78 irregular, low, stout, sometimes bifurcate teeth. Oral diameter 0.42–0.46 (0.44) t.l., 0.46–0.50 (0.48) length of bowl, or 1.07–1.17 (1.13) nuchal diameters. Collar only slightly differentiated from bowl by an angular (5–10°, rarely 25°) change in contour; an inverted, truncate section of a cone (40–56°) 0.08–0.09 t.l., or 0.16–0.20 (0.19) o.d. Nuchal diameter 0.85–0.92 (0.88) o.d.; nuchal opening 0.88 o.d.; nuchal shelf angular (88°), scarcely projecting. Bowl a very elongate convex cone (23°), 1.99–2.16 (2.08) o.d., or 0.9 t.l., anteriorly an inverted truncate segment of a cone 10–12° for 0.48–0.62 (0.55) t.l. and posteriorly an inverted, truncate cone of 39–42° for 0.28–0.34 (0.31) t.l. Aboral end terminates in an asymmetrical, oblique, or sinuous, peg-like, blunt aboral horn, a cone of 22°, 0.07 o.d. in length, with a central canal open at tip. Wall with well-defined, coarse, fairly regular, sharp-angled, predominately pentagonal or hexagonal secondary polygons; uniform in size in all parts of lorica, except near oral margin; 25–34 across one face at nuchal groove, 40–50 from this level to aboral end, and 4 rows of uneven diameters in collar; in one layer throughout. Animal of this huge species has never been seen, but one lorica at Sta. 4574 contained a subglobular, cyst-like body 84μ in diameter.

Three loricæ: L., total, 296–330 (313); collar, 24–28 (26); bowl, 271–302 (288). D., oral, 136–142 (139); nuchal, 121–125 (123)μ. A fourth lorica not included above had a length of 265μ and an oral diameter of 115μ.

At 3 stations, viz., at 1 each in California and Peruvian currents and Drift; at 69°; 8 loricæ.

Cyttarocylis mucronata Kofoid and Campbell

Plate 7, fig. 1

Lorica medium-sized, goblet-shaped, with moderately flaring collar, abrupt nuchal groove, convex conical bowl, short conical pedicel, and bluntly rounded aboral end with minute mucronate point; 1.20–1.27

(1.23) o.d. Oral margin minutely and irregularly denticulate with 72 tiny, acute, erect teeth. Oral diameter 0.79–0.83 (0.81) t.l., 0.77–0.79 (0.78) of bowl, or 1.20–1.28 (1.23) nuchal diameters. Collar sharply set off by an angular change in contour; 0.14–0.17 (0.15) o.d., or 0.11–0.13 (0.12) t.l., a truncate, inverted segment of a cone (60–70°) with uniformly convex sides. Nuchal diameter 0.78–0.83 (0.81) o.d., nuchal opening 85.8 o.d.; and nuchal angle 135°. Bowl a convex cone (39–42°), 1.26–1.30 (1.29) o.d., or 0.95–0.98 (0.96) t.l., changing from 12° below collar to 72° above pedicel. Pedicel an inverted cone (30–34°), 0.17–0.20 (0.18) t.l., or 0.2 o.d., equalling its basal diameter in length. Aboral end abruptly angularly (128°) flattened, with a minute, rounded emergent, closed point. Wall with well defined, less regular, sharp-angled secondary pentagonal or hexagonal polygons, 35 across one face of neck, 37–40 across middle, 35–52 from end to end, and in 3–6 rows in collar; larger in anterior than in aboral half of bowl, and those of pedicel only a fourth size of larger ones; in one layer, except for 2 at base of collar, each secondary polygon enclosing 20 primary hexagonal prisms in 2–4 layers. Nuchal ledge low, suberect, with gutter around base of collar.

Three loricæ: L., total, 142–150 (147); bowl without pedicel, 124–133 (129); pedicel, 23–25 (23.6). D., oral, 92–104 (96) μ.

At 12 stations, viz., at 2 and 10, respectively, in Easter Island Eddy and Drift; at 68–81 (76)°; 44 loricæ.

Cyttarocylis ricta Kofoid and Campbell

Lorica very wide, short, inverted beehive-shaped, with steep collar, shallow nuchal constriction, wide conical bowl, bluntly pointed aboral end, and fine secondary mesh; 0.78–0.89 (0.84) o.d. Oral margin irregularly denticulate, with 100 equidistant, subequal, irregular, sometimes bifurcate, sharp-pointed, triangular teeth. Oral diameter 1.12–1.28 (1.19) t.l., 1.21–1.38 (1.29) lengths of bowl, or 1.05–1.09 (1.07) nuchal diameters. Collar thinning out to delicate margin and flaring 45° from vertical; indistinctly set off externally from bowl, an inverted short segment of a truncated cone (50°), 0.07 t.l., or 0.06 o.d., with plane sides. Nuchal diameter 0.94 o.d.; nuchal aperture 0.86; nuchal angle 170°; and nuchal shelf slightly developed. Bowl wide, convex conical (34°), with bluntly angled tip; 0.93 t.l., or 0.72–0.83 (0.77) o.d. Aboral end closed, somewhat flattened, with no projecting point. Wall with well defined but very fine, fairly regular, triangular to hexagonal sharp-angled secondary polygons. Polygons about equal in size at all

levels, except for a few scattered larger ones twice diameter of smaller; 40 across one face below nuchal level, 33 from this to aboral end, 35 across middle, and 3–5 across collar; in a single layer everywhere. Each secondary polygon in section encloses 20–70 minute, mostly hexagonal, primary prisms in 6–8 layers. Animal fills 0.08 of lorica, has numerous large food bodies, and 20 membranelles.

Two loricæ: L., total, 108–118 (113); collar, 8–9; bowl, 100–109 (104.5). D., oral, 132–138 (135); nuchal, 122–131 (126.5) μ.

At 4 stations, viz., at 1 and 3, respectively, in California Current and Drift; at 75–81 (78)°; 4 loricæ.

VI. PTYCHOCYLIDÆ Kofoid and Campbell emended

Ptychocylidæ, *partim*, K. and C., 1929, p. 172 (see Epiplocylidæ for Epiplocylis, Epiorella, and Epicancella).

Cyttarocylidæ, *partim*, K. and C., 1929, p. 108 (see also Xystonellidæ).

Favellineæ, *partim*, K. and C., 1929, p. 116 (for Porœcus, Favella, Cymatocylis, and Protocymatocylis see this family; for Parafavella see Xystonellidæ).

Non Cyttarocylineæ K. and C., 1929, p. 108 (see Cyttarocylidæ).

Tintinnoinea with inverted bell-shaped or kettle-shaped lorica; circumoral rim with or without denticles, with lip and furrow in Cymatocylis; wide flaring collar lacking; suboral region with spiral lamina in some species of Porœcus and Favella, sometimes with one or two bulges but not otherwise annulate; bowl often elongate, cylindrical, more or less conical anteriorly, contracting abruptly posteriorly; often with a well developed aboral horn, simply pointed, or rounded; wall with coccoliths in Porœcus only; trilaminate, with fine alveolar mesh in middle; lorica short, longitudinal surface rugæ present in Protocymatocylis, Cymatocylis, Ptychocylis, and some species of Favella; two macronuclei and two micronuclei; marine, neritic, and eupelagic in Arctic, Antarctic, and tropical seas.

The Ptychocylidæ constitute a much diversified family of widely different ecological relations.

We have erected the Epiplocylidæ for Epiplocylis, Epiorella, and Epicancella on the ground of uniqueness of pattern of wall characterized by aboral reticulations merging anteriorly into free longitudinal or spiral lines. To Ptychocylis we have added the subfamily Favellinæ (except Parafavella) of the Cyttarocylidæ to form the Ptychocylidæ. This left Cyttarocylis as the only genus in the Cyttarocylidæ. The

genera removed from that family to the Ptychocylidæ were Porœcus, Favella, Protocymatocylis, and Cymatocylis. Because of elongated shape of lorica and aboral horn we have moved Parafavella from Cyttarocylidæ (Favellinæ) to the Xystonellidæ, where it is little less a misfit than in the Ptychocylidæ.

The Ptychocylidæ, as here redefined, is constituted of five genera, viz., Porœcus (5 species); Favella (18); Ptychocylis (10); Protocymatocylis (3); and Cymatocylis (45).

Cymatocylis and Protocymatocylis are Antarctic genera whose loricæ have simple walls with short surface rugæ or plicæ. Cymatocylis has a channeled oral margin, whereas Protocymatocylis has but a thin, simple rim. Favella also has a simple rim, with suboral region built up of a spiral lamina for a short distance only; this genus is characteristically one of northern temperate neritic regions, and was not recorded by Laackmann (1909) from the Antarctic. The *Favella campanula* series of small species is, however, eupelagic and tropical. Porœcus is generally coccolith-bearing, tropical in distribution, and eupelagic in habit. Ptychocylis differs from the other genera in more generally having teeth on oral margin. It is Arctic or cold-temperate in occurrence. Protocymatocylis and Cymatocylis are entirely lacking in the collections of the Expedition, although many of its collections were taken in the Peruvian Current, which receives large contributions from the Antarctic. Likewise, the genus Ptychocylis of Arctic and northern distribution did not appear in the collections of the "Albatross" in the California Current fed from the Northern Pacific. Representation of the Ptychocylidæ in Expedition collections is limited to four species of the little known genus Porœcus, of tropical oceanic distribution, and to *Favella azorica* and *panamensis*.

12. PORŒCUS Cleve emended Kofoid and Campbell

Ptychocylidæ with lorica tall, inverted, cylindrical, campanulate, with or without feebly developed, non-septate annuli; oral margin entire, irregular; no suboral differentiation; bowl cylindrical above, inverted conical or hemispheroidal below; aboral horn usually present; wall with two laminæ and intermediate layer filled with coccoliths; marine, eupelagic in tropical seas. Type species *Porœcus apiculatus* (Cleve, 1900d, fig. 9) Cleve (1902b, p. 15) from South Atlantic.

Established by Cleve (1902b) with only the type species, *Porœcus apiculatus*. He had earlier (1900d) used the generic name, Porella, but

this had been used before by Gray (1848) in the Bryozoa. Brandt (1907) inadvisedly rejected the genus, assigning the species to Cyttarocylis. Jörgensen (1924) restored it, and we (1929) added 4 species, 3 of which were new in our material. Little known because of rarity of material, due to small size and easy escape through mesh of plankton net.

Closest to Favella in pattern of lorica, though smaller. Differs from it in simpler wall, lack of suboral differentiation, and less regular prismatic structure. It also makes extensive use of coccoliths, unlike other genera of Ptychocylidæ. Resembles *Tintinnopsis strigosa, acuminata,* and *wailesi* (see K. and C., 1929, figs. 31, 43, and 44) in size and proportions, and seems to be a connecting link between the Codonellidæ and Ptychocylidæ, of which it is the most primitive genus, lacking as it does circumoral and suboral structures of Favella, Ptychocylis, and Cymatocylis.

Contains 5 species, of which 4, including 3 new ones, are present in Expedition collections, and one other was given a new name.

Porœcus annulatus Kofoid and Campbell

Plate 7, fig. 5

Lorica small, very slender chalice-shaped, with long subcylindrical bowl with 2 low annuli, and bulging, convex conical aboral region with very stout, blunt aboral horn; 2.79 o.d. Oral margin irregular, thinned, and erect. Oral diameter 0.36 t.l. Bowl subcylindrical in anterior 0.7 t.l., or 2.5 o.d., subdivided into 4 sections; the first a short segment of a cone (25°) 0.05 t.l., or 0.17 o.d.; immediately below it a broad rounded ring 0.21 o.d. in length, and a diameter at its middle of 1.17 o.d., located at 0.04 t.l. from oral margin; immediately below this ring a subcylindrical section 0.45 o.d. in length, and diameter equaling o.d.; below it the second ring 0.28 o.d. in length and diameter at its middle of 1.17 o.d., located at 0.28 t.l. from oral margin. Long subdivision below this ring 0.3 t.l., subcylindrical, laterally concave, with anterior and posterior diameters equaling oral, and middle diameter reduced to 0.9 o.d., flaring posteriorly into bulbous aboral region, convex subconical (60°) below, 0.23 t.l., to base of aboral horn, or 0.7 o.d., with greatest diameter equaling oral diameter. Aboral horn a short cone (37°) 0.07 t.l., or 0.27 o.d., equaling its own anterior diameter. Tip closed, hemispherically rounded. Wall made up of uniform, scarcely detectable secondary polygons; coccoliths of *Coccolithophora leptopora*

and *pelagica* scattered below oral margin, thicker and closer together on first annulus, lacking on cylinder below it, and abundant again on second annulus and aboral 0.4 t.l.; and arranged at all levels in a low spiral.

L., total, 85; horn, 8. D., oral, 27; rings, 30μ.

At Sta. 4707 in Drift; at 72°; 1 lorica.

Porœcus apicatus Kofoid and Campbell

Plate 7, fig. 7

Lorica small, bullet-shaped, fairly stout, with a slight suboral flare, subcylindrical bowl, and conical aboral end without aboral horn; 1.86–2.07 (1.99) o.d. Oral margin irregular or ragged. Oral diameter 0.48–0.52 (0.50) t.l. Bowl cylindrical to subcylindrical in anterior half, convex conical, increasing to 60° distally in posterior half. Aboral end bluntly rounded. Wall completely filled with coccoliths in nearly every lorica. In one from Sta. 4713 these were *Coccolithophora leptopora*, of varying sizes, 3 rows of smaller ones below oral margin, followed by 4 rows of larger ones, and 10 of less regular ones in a low (7°) left spiral. A lorica from Sta. 4724 had only 4 regular rows of subequidistant coccoliths below oral margin in a left spiral (3°), while in other loricæ the rows were less regular. Coccoliths of *Coccolithophora leptopora* and *pelagica* are the most common. Secondary polygons evident when surrounding bars occasionally project above oral margin.

Four loricæ: L., total, 56μ. D., oral, 27–29μ.

At 4 stations, viz., at 1, 1, and 2, respectively, in Panamic Area, Galapagos Eddy, and Drift; at 73–79 (76.5)°; 4 loricæ.

Porœcus apiculatus (Cleve) Cleve

Plate 7, fig. 14

Lorica small, tall chalice-shaped, with long subcylindrical bowl, convex subconical aboral section, and long, tapering aboral horn; 2.59–2.69 (2.64) o.d., or 3.08–3.31 (3.19) lengths of aboral horn. Oral margin undifferentiated, wavy, and ragged. Oral diameter 0.37–0.39 (0.38) t.l. Bowl 2.2 (Cleve's lorica 3.2) o.d. in length, subcylindrical, with considerable irregularity in contour due to local bulgings and concavities, in our loricæ. Cleve's (1900d) is more uniform. Aboral region subhemispherical, becoming convex conical (90°) distally. Aboral horn a

long, narrow cone (16–20°), 0.3–0.33 (in Cleve's lorica 0.19) t.l., or 0.8–0.84 (in Cleve's lorica 0.73) o.d., with basal diameter about 0.3 its length; tapering regularly, with a blunt or pointed closed tip. Wall composed of subequal, subcircular to subpentagonal secondary polygons, with rounded angles and thin beams; 20 across bowl and 70 from end to end, each enclosing 5–30 small subhexagonal primary prisms in 2–4 layers. Each secondary polygon almost always contains a coccolith, at Sta. 4724 *Umbilicosphæra mirabilis* and *Coccolithophora pelagica*. Coccoliths are irregular in assortment, location, and level on wall. Polygons in a single layer enclosed within very thin inner and outer hyaline lamellæ.

Two loricæ: L., total, 83–86 (84.5); aboral horn, 26–27 (26.5). D., oral, 32; horn, 10.

At Sta. 4583 in California Current and 4724 in Drift; at 79–83 (81)°; 4 loricæ.

Porœcus curtus Kofoid and Campbell

Plate 7, figs. 4, 10–13

Lorica small, relatively stout, tall goblet-shaped, with anteriorly cylindrical bowl, hemispheroidal aboral region with short, stout, blunt aboral horn; 1.73–2.88 (2.31) o.d., or 6.50–10.00 (7.82) lengths of aboral horn. Oral margin usually entire, in some loricæ with heavy trabeculæ of secondary mesh projecting on oral rim in an irregularly ragged or serrate margin. Oral diameter 0.35–0.58 (0.43) t.l. Bowl cylindrical for 0.54–0.70 t.l., or 1.40–1.97 o.d., with minor changes of contour due to local modifications. Aboral horn a blunt cone (28–38°) 0.10–0.15 (0.13) t.l., or 0.27–0.33 (0.30) o.d., subequal to its basal diameter. Tip broadly rounded, 0.15 o.d. in diameter. Wall made up of fine primary prisms and secondary polygons or rounded fields of uniform size, 16 across one face, 22–29 from oral to aboral end. Some loricæ entirely free from coccoliths, while others have one in every field, even to tip of horn. Arrangement of secondary fields and coccoliths in almost transverse rows is indicative of spiral structure of lorica, most clearly shown in upper part of lorica and less regular in aboral third and on aboral horn, length of lorica a function of their number, short loricæ having fewer rows than long ones, ranging from 15 in very short loricæ to 29. Polygons are angular, pentagonal, hexagonal, or irregularly polygonal, with thin beams. Coccoliths noted were *Coccolithophora leptopora* and *pelagica*, less frequently *Umbilicosphæra mirabilis;* usually centered in fields, but in some instances adherent on outer sur-

face. Wall made up of a single layer of polygons between very thin inner and outer lamellæ; 0.03–0.06 o.d. thickness in cylindrical section of bowl, sometimes 0.08 below, and usually uniform throughout lorica.

Four loricæ: L., total, 52–70 (60.8); aboral horn, 7–8 (7.9). D., oral, 24–30 (26.3); base of horn, 7–10 (8.4) μ.

At 16 stations, viz., at 6, 3, 1, and 6, respectively, in Peruvian Current, Panamic Area, Galapagos Eddy, and Drift; at 67–83 (73.6)°; 24 loricæ.

13. FAVELLA Jörgensen emended Kofoid and Campbell

Ptychocylidæ with inverted, tall campanulate or subconical lorica contracted aborally into horn or point; oral margin entire, minutely denticulate, or skirted with a thin ragged crest, but never flaring; slight suboral constriction or ridges due to spiral or annulate (?) structure present in some species; never with distinct collar separable from bowl, but usually with suboral zone of one or more annuli or a spiral lamina; bowl long, inverted bell-shaped or convex conical, contracting aborally in a cone of 45–90°; wall trilaminate, with inner and outer lamellæ enclosing an intermediate layer of coarse secondary prisms and finer primary structures; marine, eupelagic, often neritic, and mainly in temperate seas. Type species *Favella ehrenbergii* (Claparède and Lachmann 1858, pl. 8, figs. 6, 7) Jörgensen (1924 pp. 30–31) emended K. and C. (1929, pp. 152–153).

Founded (1924, p. 25) and later enlarged (1927, pp. 10–11) by Jörgensen. It included a portion of Cyttarocylis as conceived by Brandt (1907). We (1929, p. 147) restricted it by withdrawal of species assigned to the new genus Parafavella and thus segregated two structurally distinct groups. The previous history of species now included in Favella is a varied one, as shown in the extensive and confused synonymy of *ehrenbergii*. Species retained in Favella were originally described in Tintinnus, Undella, and Cyttarocylis. With the removal, in this Report, of *aciculifera* to Parundella, the genus Favella is strictly unified, except for 2 species tentatively included, viz., *azorica* (Cleve, 1900d, fig. [10]) Jörg. (1924, fig. 28), in which the wall structure is unknown and the pattern of the lorica referable equally to Undella or Parundella, and *composita* Jörg. (1924, fig. 29), in which annulations are numerous and very narrow. Jörgensen (1924) has seen all of these species, as well as one which he refers (his figure 30) to Schmidt's (1901, fig. 6) *campanula*, and he shows very imperfectly the fine annulate structure in each. This last species of his we now call *F. thori*.

The figure labeled *Cyttarocylis enceerythalus* Koff. [sic] by Athanassopoulos (1930, fig. 2) is without magnification and has the aspect of a Favella, possibly *adriatica*, with which it agrees in general form. It is certainly not *Cyttarocylis euceeryphalus* (Hæckel) Kofoid. The same writer also notes (p. 474) *Favella jörgensis* [*sic*] n. sp., and also *Amphorella oxyura* var. *Lunga* [*sic*], both inadequately described.

In proportions and size it resembles some species of Tintinnopsis, such as *strigosa* Meunier (1919, pl. 22, fig. 26) and *elongata* Daday (1887b, pl. 19, fig. 15) (see K. and C., 1929, figs. 31 and 80). Its suboral spiral structure is like that in *Tps. pistillum* (Brandt, pl. 33, fig. 21) and *tubulosoides* Meunier (1910, pl. 12, fig. 10) (see K. and C., 1929, figs. 41 and 74). The derivation of Favella from some section of Tintinnopsis is thus probable. The spiraling in the upper end of the lorica in Favella is comparable to that in Codonellopsis and Helicostomella, but is not accompanied by differential structure of the wall. Spiraling is not carried so far in Favella as in the related genera Climacocylis and Coxliella.

Contains 18 species, of which 2, *azorica* and *panamensis*, are found in Expedition material; of these 18, 6 were described as new by us (1929); 1 other, *brevis*, was given a new name; only 1 of the 6 is present in Expedition material. We add another species, *thori*, based upon Jörgensen's *F. campanula* Schmidt. We remove from Favella to Parundella, *aeiculifera* Jörgensen (1924, fig. 35). Subdivided into 5 series, as follows: — the *meunieri* series, including *meunieri* and *infundibulum;* the *attingata* series, including *attingata* and *serrata;* the *fistulicauda* series, including only *fistulicauda*, with affinities to Parundella; the *campanula* series, including *campanula, azorica, composita,* and *thori;* and the *arcuata* series, including *arcuata, panamensis, adriatica, confessa, franciscana, brevis, helgolandica, markusovszkyi,* and *ehrenbergii*. *F. thori* Kofoid and Campbell mss. is Jörgensen's (1924, p. 26, fig. 30) *Favella azorica* var. *campanula*.

Favella azorica (Cleve) Jörgensen

Plate 7, fig. 9

Lorica relatively very small, rather stout goblet-shaped, anteriorly subcylindrical, and posteriorly conical; 1.62–1.93 (1.77) o.d. Oral margin entire, thinned to a sharp edge, with a slight trace of suboral flare in proximal 0.2. No differentiation into collar and bowl. No suboral spiral lamina reported. Oral diameter 0.53–0.63 (0.58) t.l. Lorica inverted, subconical (10°) in anterior 0.2, subcylindrical below

for 0.5 t.l., contracting in posterior region as cone of 60°, slightly concave laterally. Aboral end acute but not prolonged. Jörgensen (1924, p. 26) finds "fine, punctiform meshes of almost equal size all over the wall, at the very end more pallid and perhaps smaller." Possibly a Parundella.

Two loricæ: L., total, 86–87. D., oral, 45–54μ.

At 2 stations, 1 each in Mexican Current and Easter Island Eddy; at 72–82 (77)°; 10 loricæ.

Favella panamensis Kofoid and Campbell

Plate 7, fig. 3

Lorica medium sized, fairly stout, with 1–4 suboral rings, subcylindrical bowl, hemispheroidal aboral region, and short aboral horn with low, slightly spiral, alate basal ridges; 2.00–2.90 (2.37) o.d. Oral margin entire, or minutely irregular, erect, and not thickened. Oral diameter 0.34–0.50 (0.42) t.l. Suboral turns of spiral lamina 1–4, usually only 1, many loricæ with distinct traces of a second increasing in height from left to right, and 1 lorica from Panama Harbor had 4 complete rings and a trace of a fifth with distinct sutures between turns. Turns occupy 0.03–0.11 t.l., or 0.08–0.37 o.d., subequal, and 0.03 t.l. in width. Longer spiraled sections are due to addition of rings. Rim of bowl below last ring forms an everted shoulder with diameter of 1.08 o.d. and subangular contour (63°). Bowl proper made up of 2 regions, an anterior subcylindrical and an aboral hemispheroidal one. Anterior region 0.53 t.l., or 1.6 o.d., and aboral 0.6 o.d. to base of aboral horn, forming a little less than a hemisphere in contour as it approaches base of aboral horn. Aboral horn an irregularly tapering inverted cone (20°) varying in length from a low, stout one 0.2 o.d. to a longer, more tapering one of 0.8, with faint, low spiral, alate fins extending from 0.6 to nearly its whole length, deflected 12–20° from vertical with a wavy outline and a width locally of as much as 0.16 basal width of horn. A central canal traverses horn for varying distances. Tip closed. Irregularities in shape are frequent. Wall made up of very fine, angular, subregular secondary prisms enclosed between inner and outer lamellæ, ranging from 90 to 150 across one face of bowl, smaller and much fainter on rings, and larger and less regular on aboral horn, in 1–3 layers in wall, and 3–8 at base of horn; with a faint brownish tinge, fainter than the dense loricæ of *Codonellopsis biedermanni* from same region. Wall 0.02 o.d. in thickness in

rings, 0.08 in shoulder, 0.04 throughout most of bowl, and 0.06 near aboral end. Animal missing in all preserved loricæ. One of us (Kofoid) saw the animal attacked and eaten by a marine rotifer. *Favella franciscana*, a near relative, eats Tintinnopsis and Acanthostomella.

Ten loricæ: L., total, 136–232 (179.7); bowl, 104–162 (145.2); aboral horn, 15–62 (34.3). D., oral, 64–86 (75.8); at shoulder, 71–88 (80.3); base of horn, 12–28 (17.3) μ.

At 11 stations, viz., at 1, 6, 1, 1, and 2, respectively, in California, Mexican, and Peruvian currents, in Easter Island Eddy and Panamic Area, as well as at Panama Anchorage; at 79–84 (82.9)°; 14 loricæ.

VII. EPIPLOCYLIDÆ fam. nov.

Ptychocylidæ, *partim*, K. and C., 1929, p. 172 (see also Ptychocylidæ K. and C. emended for Ptychocylis).

Tintinnoinea with short, stout, inverted acorn-shaped lorica; oral rim entire; suboral region unmodified, or with circumoral collar and suboral shelf; bowl subconical to cylindrical above, stout convex inverted conical below; aboral end pointed, blunt, or acuminate; aboral horn or point present, except in Epicancella; wall partially or wholly covered with deep polygonal surface reticulations bounded by elevated ridges; free lines, vertical or spiral, may extend orally from reticulations; coccoliths not utilized in wall; probably 2 macronuclei and 2 micronuclei; marine, eupelagic in tropical seas.

Contains 3 genera: Epiplocylis (22 species), Epiorella gen. nov. (7), and Epicancella (1). Epiplocylis has neither differentiated collar nor suboral shelf, found in the other two genera. Epicancella differs from the other two in absence of aboral horn, dominant longitudinal ribs, and cancellated pattern of wall; and Epiorella from Epicancella in non-cancellated wall structure and aboral horn, and from Epiplocylis in suboral shelf and collar.

Epiplocylidæ are most closely related to Protocymatocylis and Cymatocylis of Ptychocylidæ, in which the suboral region evolves from a thin circumoral rim to a small erect collar with a suboral shelf below it, as also in Epiplocylis and Epiorella. In Protocymatocylis and Cymatocylis the circumoral rim is generally toothed, the suboral shelf often recurved, sinuous, or interrupted, and vertical linear striæ replace the reticulate mesh and vertical or spiral free lines of Epiplocylidæ. The Epiplocylidæ are tropical in distribution, but Cymatocylis and Protocymatocylis are limited to the Antarctic region.

14. EPIPLOCYLIS Jörgensen emended

Epiplocylis, *partim*, K. and C., 1929, p. 172 (see also *Epiorella* and *Epicancella*).

Epiplocylidæ with acorn-shaped lorica; oral margin entire; suboral region thinning down to a sharp-edged oral rim; never with collar but sometimes with suboral thickened zone; bowl widely convex conical to elongated cylindrical anteriorly; fundus broadly rounded, rarely subconical; aboral horn well developed, narrow conical; reticulated region never reaching oral margin; free zone 0.16–1.25 o.d. in length; vertical or spirally deflected free lines, when present, restricted to narrow region above network. Type species *Epiplocylis acuminata* (Daday, 1887b, pl. 20, fig. 33) Jörgensen (1924, figs. 63a, b) emended K. and C. (1929, p. 172), from off Naples.

Established by Jörgensen (1924) for certain species which had been included in Ptychocylis by Brandt (1907). We here separate from Epiplocylis as Epiorella those species which have a collar and suboral shelf, and raise Epicancella, which we established (1929) as a subgenus, to generic rank, thus reducing Epiplocylis to a more compact, logically definable genus.

Clearly related to Epiorella in form and general habitus, but differing in lack of a collar superimposed upon suboral shelf, better development of aboral horn, presence on bowl of region without free lines, and larger size. The thickened suboral zone in Ptychocylis is homologous with the suboral shelf in Epiorella. More distantly related to Epicancella, which has a collar, no aboral horn, and a cancellate surface. Epiplocylis differs from the distantly allied Ptychocylis in its less delicate, more elevated, larger reticulations, and thicker wall.

Contains 22 species, of which 11 are present in Expedition material. Of the 22, 14 were new and 1 is renamed in this report. Of these 14 new species, 8 are present in Expedition material. Subdivided into 4 series: — the *atlantica* series, including *atlantica, exquisita, blanda, symmetrica, impensa, lineata, undella,* and *mucronata;* the *inconspicuata* series, including *inconspicuata, deflexa, constricta,* and *pacifica;* the *sargassensis* series, including *sargassensis* and *obtusa;* and the *bruhni* series, including *bruhni, calyx, laackmanni, inflata, exigua, lata, labiosa,* and *acuminata.*

Speciation in Relation to Temperature: — There are 22 species assigned to Epiplocylis, and 12 to Ptychocylis, a related genus and its northern counterpart. There are thus only 54.5% as many species of Ptychocylis as Epiplocylis, or 1.83 species of Epiplocylis for each one

of Ptychocylis. The temperature range of Epiplocylis is 67–81° in our records, while Ptychocylis has not been recorded south of British Columbia at 60° or less. This bears out van 't Hoff's law, in that there are nearly twice as many species of the tropical Epiplocylis as there are of the semi-arctic Ptychocylis. These data, although very fragmentary, are suggestive of the relationship of speciation to temperature as between related genera in regions of contrasted temperatures.

Epiplocylis blanda Jörgensen emended Kofoid and Campbell

Plate 8, fig. 5

Lorica elongate, subcylindrical goblet-shaped; 1.82–2.04 (1.91) o.d. Bowl subcylindrical, somewhat convex laterally, and not noticeably angular, 1.46–1.73 (1.51) o.d., expanding to 1.04–1.14 (1.08) o.d. at 0.4–0.6 o.d. below rim, usually somewhat below slight shoulder. Suboral zone not thickened. Oral rim with slight trace of eversion, though its inner face flares abruptly outward with convex contour with a lateral outline so evenly convex as to conceal this. Fundus convex subconical (70–80°), passing gradually into stout aboral horn 0.25–0.50 (0.40) o.d. in length with basal diameter 0.5–1.0 its length, and blunt, closed tip. Reticulated zone 0.33–0.55 o.d. in length, with 13–18 areas across its upper edge on one face, and 6–8 vertically. Free lines 0.15–0.30 o.d. in length, sinuous subvertical, deflected up to 35° to left. Wall with 3 layers of minute, uniform, regular primary prisms between thick lamellæ, and 100–110 across one face.

Ten loricæ: L., total, 116–126 (120.6); bowl, 89–108 (85.4); horn, 16–31 (25.2). D., oral, 58–64 (63.2); greatest, 66–70 (68.3) μ.

At 23 stations, viz., at 4, 4, 7, 2, 3, and 3, respectively, in California, Mexican, Peruvian, and South Equatorial currents, Panamic Area, and Drift; at 67–85 (74.6)°; 126 loricæ.

Epiplocylis constricta Kofoid and Campbell

Plate 10, figs. 1–3, 6

Lorica low, stout goblet-shaped, 1.17–1.38 (1.28) o.d. Bowl contracting toward oral opening in a gentle curve from widest part (1.04–1.19 [1.1] o.d.) at 0.4–0.5 o.d. below rim, contracting below without shoulder in a convex curve to aboral horn. Fundus convex conical (70–90°), but with less fullness than in *pacifica*, and somewhat less than a hemisphere. Aboral horn slender tapering conical (15–22°), termi-

nating in a sharp, closed tip, sometimes deflected or curved; 0.40–0.55 (0.46) o.d. in length, with basal diameter 0.4–0.5 its length. Reticulated zone 0.3–0.4 o.d. in length, with larger and more regular areas than in other species; 12–15 across one face and 5–7 vertically. Free lines relatively long (0.16–0.40 o.d.), deflected to left (15–50°). Only uppermost part of horn fluted. Primary prisms larger, 100–110 across one face, in expanded part of bowl. Wall with thin lamellæ and 3–4 layers of prisms.

Ten loricæ: L., total, 95–103 (97.1); bowl, 66–76 (71.4); horn, 22–30 (25.7). D., oral, 53–58 (55.8); greatest, 56–65 (61.6) μ.

At 28 stations viz., at 4, 8, 1, 1, 3, and 11, respectively, in California, Mexican, and South Equatorial currents, Galapagos and Easter Island eddies, and Drift; at 69–85 (78.4)°; 102 loricæ.

Epiplocylis deflexa Kofoid and Campbell

Plate 10, figs. 5, 7, 10

Lorica small, short, rotund goblet-shaped; 1.48–1.86 (1.65) o.d. Oral rim everted, abruptly thinned. Bowl rotund, expanding below to 1.07–1.21 (1.12) o.d. at 0.3–0.4 o.d. below rim, to faintly rounded shoulder, then gradually contracting in convex outline into broadly convex, subconical (85–90°) fundus with contour less than a hemisphere. Length of bowl 1.24–1.53 (1.35) o.d. Aboral horn slender, tapering concave conical (25°), 0.15–0.36 (0.29) o.d. in length, with basal diameter 0.50–0.75 its length, fluted nearly to its closed sharp tip. Reticulated zone 0.40–0.75 o.d. in length, extending to oral rim, with lighter mesh in upper part than lower, and often larger, irregular, uneven areas in upper levels; 14–18 across one face at upper margin, and 6–9 vertically. Leiotropic free lines very long, up to 0.6 o.d. in length, very oblique, up to 60° from vertical, sometimes anastomosing. Finer structure of wall characteristic, with inner lamellæ heavier than outer and primary reticulations larger than in any other species, except in the closely related *bruhni*, especially in zone of free lines, decreasing in thinning rim to minute prisms 0.4 diameter of those below, 50–70 in zone of largest prisms on suboral shoulder and 100–150 at oral rim. These large prisms are of the Cyttarocylis type, forming but a single layer of radial prisms, a condition found in no other species. Wall relatively thick, attaining 0.07–0.12 o.d. at suboral shoulder. A lorica at Sta. 4583 contained a spherical cyst 44 μ in diameter in upper part of bowl in a mass of cytoplasm in which no nucleus was found. Cyst con-

tained 2 macronuclei; the micronuclei were not determined, and had a thin, double-contoured wall.

Ten loricæ: L., total, 86–104 (93.3); bowl, 70–84 (76.8); horn, 14–20 (16.5). D., oral, 53–60 (56.5); greatest, 59–68 (63.4) μ.

At 17 stations viz., at 1, 6, 1, 1, 6, and 2, respectively, in California, Mexican, South Equatorial, and Equatorial Counter currents, Panamic Area, and Drift; at 72–85 (80.0)°; 71 loricæ.

Epiplocylis exigua Kofoid and Campbell

Plate 9, figs. 8, 11

Lorica very small, short, moderately rotund goblet-shaped, tapering aborally with sharp, conical aboral horn, 1.57–1.90 (1.68) o.d. Bowl 1.17–1.57 (1.29) o.d. in length, convex subconical (10–12°) in upper 0.5. Slightly expanded suboral region interrupting this subconical contour and thickened for 0.45–0.60 o.d. below rim. Bowl with greatest diameter (1.07 o.d.) at middle of suboral zone. Fundus less than hemisphere, convex conical (60–80°) in lower third, contracting to slender, sharp, conical (13–20°), fluted aboral spine 0.30–0.43 (0.39) o.d. in length, with basal diameter 0.20–0.25 o.d. and 0.5–0.6 its length. Wall thickest in suboral zone, thinnest below, and thickening distally towards base of aboral spine, which is solid, except for a short canal in its base. Wall non-reticulated for 0.25–0.40 length of bowl, with primary prisms only, in 2–4 layers in suboral zone, 50–65 across one face. Reticulations somewhat sharp-angled, irregular in size, irregularly polygonal, generally longer vertically, extending to base of horn, 16 across one face and 12 from suboral zone to base of horn, which is encircled by 6–7 narrow polygonal arches whose elongating boundaries vanish distally. Free lines feebly developed as a fringe and very short.

Five loricæ: L., total, 74–81 (77.8); bowl, 55–62 (59.8); horn, 14–20 (18). D., oral, 44–47 (46.4); greatest, 47–50 (49) μ.

At 9 stations, viz., at 2 and 7, respectively, in Peruvian Current and Drift; at 68–72 (69.3)°; 45 loricæ.

Epiplocylis exquisita Kofoid and Campbell

Plate 9, figs. 5, 12

Lorica wide goblet-shaped, convex conical to almost subhemispherical below; 1.75–1.96 (1.84) o.d. Bowl without suboral flare, expanding at 0.5–0.6 o.d. below rim to a slight but well rounded suboral shoulder,

1.02–1.09 (1.05) o.d. in diameter, without or with a slight flare below rim resulting in a slight concavity in lateral contour, so that inner face of suboral region for 0.12 o.d. is a truncated segment of a cone (45°). Below rounded angular shoulder bowl contracts with a gradual curve into broadly subconical fundus (60–85°). Bowl 1.32–1.55 (1.44) o.d. in length (in Brandt's lorica, his pl. 61, fig. 1, only 1.00). Fundus merges gradually in narrow loricæ, less so in wider ones, into the sharp, closed, conical (20–30°) aboral horn, 0.28–0.50 (0.40) o.d. in length, with basal diameter 0.45–0.80 its length, with surface fluted almost to closed tip. Reticulated zone 0.28–0.50 o.d. in length, with 20 uneven, irregular areas across one face along upper edge and 5–8 vertically. Free lines short, 0.12–0.30 o.d. in length, subvertical or sloping to left up to 25°. Primary prisms minute, regular, 125 across one face on shoulder, in 4 layers between thick lamellæ.

Fifteen loricæ: L., total, 94–110 (102); bowl, 74–84 (79.8); horn, 15–28 (22.2). D., oral, 53–58 (55.5); greatest, 55–59 (58) μ.

At 26 stations viz., at 1, 2, 1, 1, 5, and 16, respectively, in California, Peruvian, and South Equatorial currents, Panamic Area, Easter Island Eddy and Drift; at 69–81 (74.2)°; 103 loricæ.

Epiplocylis impensa Kofoid and Campbell

Plate 9, fig. 3

Lorica elongated, tapering goblet-shaped; 1.92–2.14 (2.01) o.d. Oral rim gradually thinning convexly from within for 0.12 o.d. Bowl 1.13–1.15 o.d. in length, widest at oral rim, inverted conical (5°) for 0.33 o.d. below rim, to level of angled shoulder; convex conical (33–35°) below for 0.35–0.40 of bowl. Reticulated aboral region inverted, convex conical (75–90°), with contour less than a hemisphere. Aboral horn conical (25–37°), concave basally, 0.28–0.33 o.d. in length, with basal diameter 0.52–0.60 its length. Reticulated zone 0.4–0.5 o.d. in length, with 18–20 irregular, unequal areas at top across one face and 5–8 vertically. Free lines subvertical, 14–18 across one face, not over 0.16 o.d. in length. Wall thin, thickest in suboral zone, thinning aborally to half this in lower bowl, but thickening at base of aboral spine to maximum thickness with 2–3 layers of primary prisms.

L., total, 116; bowl, 94; aboral horn, 22. D., oral, 60μ.

At 6 stations, viz., at 4 and 2, respectively, in California Current and Drift; at 69–83 (76.5)°; 6 loricæ.

Epiplocylis lata Kofoid and Campbell

Plate 9, figs. 6, 9

Lorica wide, short, thick-rimmed goblet-shaped, with cylindrical bowl, abruptly contracting to long, sharp, conical horn; 1.64–2.00 (1.75) o.d. Suboral zone abruptly and narrowly thickened in uppermost 0.2–0.3 of bowl, 0.1 o.d., contracting more abruptly orally than aborally to a thin, entire, vertical oral rim. Bowl 1.10–1.36 (1.22) o.d. in length, cylindrical in upper 0.66, widest (1.1 o.d.) on suboral zone, contracting abruptly in lower third to fundus having contour exceeding that of a hemisphere, a convex cone (90–100°), and then to aboral spine. Aboral spine 0.44–0.64 (0.53) o.d. in length, tapering concave conical (12–20°), with sharp tip, fluted upper shaft, basal diameter 0.16–0.33 o.d. and 0.3–0.5 its length, and central canal in upper 0.25–0.33. Wall in suboral zone with 3–5 layers of small primary prisms, thinning down to 1 in reticulations. Reticulated zone on lower 0.7–0.8 of bowl. Reticulations irregular polygonal, not uniform in size, largest 2–3 times diameter of smaller ones, generally longer vertically than transversely; 14–16 across one face and 12 from suboral zone to base of spine. Free lines wholly lacking.

Ten loricæ: L., total, 78–94 (86.5); bowl, 56–64 (60.4); horn, 22–30 (26.1). D., oral, 47–52 (49.3); greatest, 52–56 (53.5) μ.

At 31 stations, viz., at 1, 2, 1, 1, 1, 2, and 23, respectively, in California, Mexican, Equatorial Counter, and South Equatorial currents, Easter Island and Galapagos eddies, and Drift; at 69–81 (75.3)°; 589 loricæ.

Epiplocylis pacifica Kofoid and Campbell

Plate 10, figs. 8, 9

Lorica stout, medium-sized, rounded goblet-shaped; 1.70–1.93 (1.82) o.d. Suboral thickened zone 0.66 o.d. in length. Bowl long, 1.27–1.44 (1.35) o.d. in length, expanding to 1.05–1.19 (1.11) o.d. at 0.4–0.5 o.d. below rim. Lateral outline broadly rounded or slightly angled (165°) at level of greatest diameter. Bowl below suboral angle inverted subconical (13–20°), changing in convex subconical fundus to 80–90°. Aboral horn 0.36–0.58 (0.47) o.d. in length, with basal diameter 0.4–0.5 its length, slender, slightly concave conical (12–15°), and tapering to a sharp, closed tip. Reticulated zone 0.45–0.60 o.d. in length, terminating above in free lines, 0.20–0.45 o.d. in length, shorter ones subvertical, with some obliquity to the left, in longer ones becom-

ing more pronounced (5–25°). Reticulations clear-cut and well defined, uneven in size and irregularly rounded, 30–40 across top and 18–20 vertically. Shaft of aboral horn fluted nearly to tip. Primary prisms minute, regular, 90–100 across one face, and in 3 layers between rather heavy inner and outer lamellæ.

Ten loricæ: L., total, 104–115 (109.3); bowl, 77–89 (81.2); horn, 22–34 (28.1). D., oral, 58–63 (59.9); greatest, 64–69 (66.2) μ.

At 58 stations, viz., at 4, 7, 1, 3, 1, 9, 1, 3, and 29, respectively, in California, Mexican, Peruvian, South Equatorial, and Equatorial Counter currents, Panamic Area, Easter Island and Galapagos eddies, and Drift; at 69–85 (76.2)°; 252 loricæ.

Epiplocylis sargassensis (Brandt) Kofoid and Campbell

Plate 8, figs. 1, 6

Lorica large, tall, tapering goblet-shaped; 1.88–2.20 (2.03) o.d. Bowl 1.65–1.96 (1.75) o.d. in length, narrowly conical, subcylindrical (not over 17°) in upper 0.5, with slight oral flare at rim, convex laterally, contracting abruptly below for 0.33 o.d. into convex conical (55–65°) fundus, which passes gradually into stout, conical (25–45°) aboral horn, terminating in blunt, closed tip. Horn 0.20–0.46 (0.28) o.d. in length, with basal diameter 0.65–1.00 its length, traversed nearly to tip by central canal, and fluted almost to tip. Reticulated zone 0.6–0.7 o.d. in length. Reticulations relatively small, irregular in outline and uneven in size, rounded, with much thickened mesh; 22–27 across one face in uppermost rows, and 10–13 vertically. Free lines absent or very short, subvertical, not over 0.21 o.d. in length, slightly oblique, and sinuous, with few anastomoses. Primary prisms very small, 3–5 layers in thickness, and 100–150 across one face at widest part.

Ten loricæ: L., total, 113–132 (123.3); bowl, 99–116 (106.2); horn, 12–28 (17.1). D., oral, 59–65 (60.7); greatest below oral, 59–68 (61.6) μ.

At 27 stations, viz., at 2, 4, 1, and 20, respectively, in Peruvian Current, Easter Island and Galapagos eddies, and Drift; at 68–81 (74.3)°; 91 loricæ.

Epiplocylis symmetrica spec. nov.

Plate 8, fig. 3

Lorica elongated goblet-shaped, with conical fundus; 1.92–2.14 (2.00) o.d. Suboral zone not clearly defined by either local thickening

or shoulder. Bowl 1.62–1.80 (1.66) o.d. in length, subcylindrical in anterior 0.4, with slightly convex contour, widest (1.02–1.10 [1.05] o.d.) at 0.4–0.6 o.d. below rim. Fundus subconical (28–30°), passing abruptly into conical (15–25°), pointed aboral horn, 0.28–0.45 (0.35) o.d. in length, with basal diameter 0.5–0.8 length, with elongated reticular flutings on surface. Reticulated zone 0.45–0.65 o.d. in length, with 20–25 uneven, irregular areas at top across one face and 5–8 vertically. Free lines subvertical, somewhat irregular in direction, 0.14–0.30 o.d. in length. Upper non-reticulated zone with minute, regular primary prisms, 2–3 layers in thickness and 100–125 across one face. Wall nearly uniform throughout whole lorica, unusually thin, only 0.07 o.d. in thickness in suboral region, more hyaline and flexible than in other species.

Nine loricæ: L., total, 115–126 (118.8); bowl 94–108 (98.1); horn, 17–24 (20.7). D., oral, 56–60 (58.9); greatest, 59–65 (62.1) μ.

At 3 stations in California Current; at 69–76 (71.3)°; 5 loricæ.

Epiplocylis undella (Ostenfeld and Schmidt) Jörgensen emended Kofoid and Campbell

Plate 9, figs. 1, 2, 4, 7, 10

Ptychocylis undella, Gräf, 1909, pp. 154, 158, 193, 195, figs. [9]e, [11]b, [28]d, [29]f.

Lorica large, stout, slightly angled, low goblet-shaped; 1.91–2.23 (2.09) o.d. Bowl relatively short, 0.74–0.81 (0.76) t.l., or 1.42–1.69 (1.60) o.d., cylindrical above or with slight constriction below lip and expansion to 1.06–1.14 (1.05) o.d. at 0.4 o.d. below lip to a slight shoulder, contracting below (13–20°), usually with some convexity, for 0.8–1.0 o.d., and then abruptly into subconical (72–90°) convex fundus. Aboral horn 0.19–0.26 (0.24) t.l., or 0.39–0.55 (0.49) o.d., with basal diameter 0.10–0.75 its length, and blunt, closed tip, with or without central canal. Reticulated zone 0.40–0.45 o.d. in length. Free lines deflected to the left not to exceed 20°, 0.10–0.22 o.d. in length. Reticulations very distinct, with mesh not heavily thickened, irregular, uneven, 16–22 across face at upper edge, and 8–10 vertically. Upper 0.5 of horn fluted. Wall above reticulated zone with 135–150 faint, minute, and regular primary prisms across one face, with 3–4 layers of prisms between thin inner and outer lamellæ. Two ellipsoidal macronuclei, 2 micronuclei, and 23 membranelles. Ovoidal, thin-walled cysts seen in loricæ.

Ten loricæ: L., total, 132–154 (139.9); bowl, 98–125 (106.8); horn, 28–36 (32.8). D., oral, 64–74 (66.8); greatest, 68–74 (70.3) μ.

Ostenfeld and Schmidt's (1901, fig. 30) original figure and their recorded dimensions are not in agreement as to proportions. They give "length, 140–157 μ." If the loricæ be extended to 140 and 157 μ, respectively, the proportions fall within those of Brandt's figure (pl. 59, fig. 5) of var. *m* and also within his dimensions, and but slightly exceed ours. We therefore regard Brandt's var. *m* as belonging to the species originally described by Ostenfeld and Schmidt.

At 35 stations, viz., at 3, 9, 3, 1, 5, and 14, respectively, in California, Mexican, South Equatorial, and Equatorial Counter currents, Panamic Area, and Drift; at 71–85 (79.8)°; 196 loricæ.

15. EPIORELLA gen. nov.

Epiplocylis, *partim*, K. and C., 1929, p. 173 (see also Epiplocylis and Epicancella.)

Epiplocylidæ with acorn-shaped loricæ and well developed circumoral structures; oral margin entire; oral opening relatively wide; collar a low, erect, hyaline band thickened basally; suboral shelf projecting as a lip, with flattened upper surface; bowl cylindrical, globose, or convex-conical anteriorly, and convex-conical or broadly rounded posteriorly; aboral end with an acuminate point or at most short aboral horn, not over 0.33 o.d. in length; wall with prominent polygonal surface reticulations not reaching suboral shelf, except in *ralumensis;* free lines, usually present above reticulations; marine, eupelagic in warm temperate and tropical seas. Type species *Epiorella reticulata* (Ostenfeld and Schmidt, 1901, p. 180, fig. 28) from 25° 15′ N., 35° 26′ E., in Red Sea, species first described in genus.

Closely related to Epiplocylis in form, but differing markedly in addition of a crest-like collar and distinct suboral shelf. Epiorella has in these additions a relationship to Epiplocylis similar to that of Codonaria to Codonella. Aboral horn relatively shorter, free lines more nearly vertical, and lorica smaller than in Epiplocylis. Resembles Epicancella in having a collar and shelf, but differs in never having a cancellate wall and always having an aboral horn, or point.

Contains 7 species, all transferred from Epiplocylis, of which 4 are in Expedition material; of the 7, 4 are new, and of the 4, 3 are present in Expedition material. Subdivided into 2 series:—the *freymadli* series, including *freymadli, reticulata,* and *ralumensis;* the *acuta* series, including 4 species, *acuta, brandti, healdi,* and *curta.*

Epiorella acuta (Kofoid and Campbell)

Plate 8, figs. 2, 9, 11

Lorica small, short goblet-shaped, with conical fundus not differentiated from aboral horn; 1.16–2.05 (1.56) o.d. Collar low, 0.03 o.d. in height, vertical on inner face, sloping (30°) on outer, with thickened base, and an entire oral rim. Suboral shelf or ring triangular (70°) in section, oblique or convex below and above; its vertical height and diameter 0.05–0.08 (0.06) and 1.14–1.29 (1.21) o.d., respectively. No trough between collar and ring. Bowl 1.16–1.70 (1.37) o.d. in length, convex tapering cylindrical in upper 0.3, tapering subconical (65–75°) in lower 0.3, contracting with slight lateral concavity distally into aboral horn. Aboral horn solid, not sharply set off from bowl, 0.18–0.35 (0.23) o.d. in length, conical (35–50°), with sharp closed tip; its basal diameter 0.08–0.25 o.d. and 0.4–0.9 its length. Wall with irregular, uneven reticulations on lower 0.5–0.7 of bowl, and above with longitudinal, occasionally dividing, or anastomosing free lines with few oblique or transverse bars. Elevation of free lines above enclosed areas much less than in reticulations. Uppermost parts of lines sometimes curve to the right, but their tips to the left; 20–28 lines and a few more areas in reticulate region below across one face, and 10–18 areas vertically to base of spine, which is also covered by reticulations imperfectly developed distally as fluting.

Ten loricæ: L., total, 59–70 (65); bowl, 51–68 (57.3); spine, 8–14 (9.7). D., oral, 38–44 (41.7); suboral shelf, 48–52 (50.3) μ.

At 59 stations, viz., at 2, 4, 25, 8, 1, 3, and 16, respectively, in California, Mexican, and Peruvian currents, Panamic Area, Easter Island and Galapagos eddies, and Drift; at 66-84 (72.9)°; 396 loricæ.

Epiorella curta (Kofoid and Campbell)

Plate 8, figs. 7–8

Lorica rather tall goblet-shaped, or resembling a long acorn; 1.57–1.82 (1.69) o.d. Collar a low, vertical band not over 0.05 o.d. in length, with sloping outer, and vertical inner face, and irregularly ragged oral rim. Suboral ring angular, with rounded edge, low sigmoid under surface, and no trough between it and collar. Bowl 1.43–1.64 (1.54) o.d. in length, with contour from lower edge of suboral ring gently, rarely unevenly convex, contracting in lower 0.5 to a convex conical (70–90°) fundus terminating in a short, conical (30–45°), solid, sharp-pointed aboral point; 0.04–0.22 (0.15) o.d. in length, and its base 0.5–1.0 its

length. Reticulations on lower 0.34–0.50 of bowl, with small, unequal, irregular polygons, the uppermost elongated vertically, 15–20 across one face and 8–10 vertically, turning abruptly to left on under side of shelf. Free lines, 15–18 on one face, with irregular anastomoses.

Ten loricæ: L., total, 73–80 (77.2); bowl, 66–74 (70.5); spine, 4–10 (6.7). D., oral, 44–47 (45.7); shelf, 50–55 (52.2) μ.

At 15 stations, viz., at 12 and 3, respectively, in Peruvian Current and Panamic Area; at 66–76 (69.3)°; 45 loricæ.

Epiorella healdi (Kofoid and Campbell)

Plate 8, figs. 12–14

Lorica wide goblet-shaped or like a plump long acorn; 1.33–1.92 (1.56) o.d. Collar very low, vertical, with entire oral rim, sloping or concave outer face, and vertical or slightly flaring inner one. Suboral ring lip-like, with angular or rounded outer edge, flat or channeled upper, sigmoid lower surface, and sinuous edge; 0.10–0.12 o.d. in length, and 1.11–1.24 (1.18) o.d. in diameter. Bowl 1.09–1.73 (1.41) o.d. in length, subcylindrical, or with slight taper (8–10°) in upper 0.6 of bowl, and very rapid contraction (90–125°) in fundus, which is fuller than a hemisphere, though occasionally less. Aboral horn a mere short spinule, concave-conical (15–35°), 0.07–0.26 (0.16) o.d. in length, and with basal diameter equaling or exceeding its length, with short flutings sharp closed tip, and short central canal in its base. Reticulations confined to lower 0.3–0.5 of bowl, forming an irregular network of subequal, subregular polygons, growing smaller towards base of spine and fading out distally, in short flutings. Uppermost rows feebly developed, tending to be rectangular with long axis vertical. As many rows across one face as there are longitudinal lines. Number of polygons in vertical direction in lower, heavier mesh is 8–15, with up to 15 more in lighter mesh above. Whole lorica quite transparent and mesh somewhat less distinct than in other species of the genus. Free lines on upper part of bowl forming 20–28 rather irregular, sinuous, bifurcating, or anastomosing longitudinal ridges, with a few low cross-ridges between some of them. Lower face of suboral shelf finely reticulated by a meshwork formed by upper ends of free lines.

Ten loricæ: L., total, 58–75 (66.9); bowl, 47–71 (60.2); spine, 4–11 (6.9). D., oral, 40–45 (42.8); suboral shelf, 47–51 (50.1) μ.

At 22 stations, viz., at 1, 12, 4, 3, and 2, respectively, in Mexican and Peruvian currents, Panamic Area, Galapagos Eddy, and Drift; at 65–84 (71)°; 191 loricæ.

Epiorella ralumensis (Brandt)

Plate 8, figs. 4, 10

Lorica broad goblet-shaped, with large, stout, tapering aboral horn; 1.41–1.89 (1.63) o.d. Collar erect, vertical or outwardly flaring, less than 0.1 o.d. in height, thickening rapidly to its base. Suboral shelf spreading, flat or concave above, with rounded or acute edge and sigmoid outline below; with diameter on shelf of 1.13–1.30 (1.15) o.d. Bowl 1.41–1.89 (1.63) o.d. in length; slightly rotund, with slight nuchal constriction, subcylindrical, with slight expansion at 0.5 o.d. below oral rim. Fundus with aboral taper beginning at 0.5 o.d. below oral rim, increasing rapidly, with convex-conical (80–90°) contour. Aboral horn stout, concave-conical (18–32°), solid, ending in sharp closed point, 0.25–0.62 (0.39) o.d. in length with basal diameter 0.4–0.8 its length. Wall reticulated throughout, with no free lines. Reticulations everywhere angular, or rounded polygonal, irregular, subuniform, growing smaller aborally on fundus to half their size on upper bowl, extending to under surface of shelf and even to its edge, which is composed of 3–4 layers of prisms. Upper shaft of horn fluted by longitudinal reticular ridges continuous with network above. Areas 13–18 vertically, and 15–20 across one face.

Seven loricæ: L., total, 65–85 (74.7); bowl, 52–50 (57); spine, 12–30 (17.7). D., oral, 44–47 (45.7); suboral shelf, 51–57 (52.6) μ.

At 8 stations, viz., at 2 and 6, respectively, in South Equatorial Current and Drift; at 77–81 (79.3)°; 25 loricæ.

16. EPICANCELLA (Kofoid and Campbell)

Epiplocylis, *partim*, K. and C., 1929, p. 173 as subgenus *Epicancella* (see also Epiplocylis and Epiorella).

Epiplocylidæ with convex subconical lorica; oral margin entire; collar a low, thin, erect, circumoral band; suboral shelf a low, rounded lip; bowl convex-conical; fundus subconical; aboral end blunt; no horn; surface below lip covered throughout by cancellated latticed network of a few dominant, longitudinal, branching, elevated ribs, with numerous smaller, obliquely transverse connections; marine, eupelagic in tropical seas. Type species *Epicancella nervosa* (Cleve, 1900d, fig. [7]; Jörgensen, 1924, p. 54) from Sargasso Sea.

The subgenus Epicancella was erected by us (1929, p. 173) for *Epiplocylis nervosa* (Cleve) Jörg. Cleve (1900d, p. 972, fig. [7]) described

its only species as *Cyttarocylis nervosa*, but Brandt (1906, 1907), who gave excellent figures of the lorica (his pl. 55, figs. 4–7), transferred it to Ptychocylis, including it in his subgenus Rhabdonella. Jörgensen (1924, p. 54) included it in his new genus Epiplocylis.

Clearly related to Epiplocylis, from which it differs in reticular pattern with predominant longitudinal ribs and obliquely horizontal connectives forming a lattice covering whole surface of lorica, instead of a polygonal reticulum on a part only. Resembles Epiorella in pattern of suboral differentiation, having both collar and suboral shelf; but the reticulated region of Epiorella does not reach suboral shelf except in *ralumensis*, though fine striæ may extend above the reticulated zone to shelf, but never form a cancellated pattern. It differs from both Epiplocylis and Epiorella in absence of well differentiated aboral horn.

Epicancella nervosa (Cleve)

Plate 10, fig. 4

Ptychocylis nervosa, Reichenow, 1927, p. 65, fig. 81, [2].

Lorica inverted, convex, tapering campanulate; 1.47–1.64 (1.56) o.d. Suboral ring heavy, 0.16–0.20 o.d. in length, expanding to 1.05–1.13 o.d., with shallow channel next collar, broadly rounded outer surface, and sigmoid outline below in section. Collar vertical, or flaring up to 30°, with thin, entire oral rim, not over 0.04 o.d. in length. Bowl with slight constriction below suboral ring, with maximum diameter at 0.2–0.3 o.d. below rim, equal to or less than that of suboral ring, decreasing below gradually and evenly to aboral end as a convex cone (40–45°), terminating in a blunt, slightly truncate, or even acute aboral end. No suboral free zone, no free lines, and no aboral horn. Suboral ring projecting inwardly as a rounded ridge. Wall composed of thin inner and outer lamellæ, with single layer of small, regular, uniform primary prisms between, except in suboral ring, where there are 2–3 layers of larger ones. Lattice-like network prominent, covering surface of bowl below ring throughout, formed by sinking in of outer lamella and its folding up in ridges, bordering pits thus formed. Ridges longitudinal, vertical or slightly leiotropic, and turning abruptly to the left at top; 6–8 starting from aboral end, branching to 12–18 in lower third of their course, and breaking up in a superficial, fine network on surface of ring. The 12–18 main longitudinal ribs nearly equidistant, sometimes with feebly developed, interrupted, intermediate vertical ribs between main

ribs for middle third of bowl. Transverse or circular ribs 12–20, smaller and lower than the verticals, approximately continuous around bowl, connecting the longitudinal ribs, but frequently interrupted or displaced in adjacent areas, with slight upward slope not over 5° to right, sometimes branching, oblique or imperfect, and convex above, especially near suboral ring. This cancellated reticular pattern gives the lorica a characteristic appearance, unlike that of any other species.

Ten loricæ: L., total, 72–80 (76.8). D., oral, 44–49 (46.9); suboral ridge, 46–53 (50.5) μ.

At 21 stations, viz., at 3, 7, and 11, respectively, in Peruvian Current, Easter Island Eddy, and Drift; at 68–75 (71.3)°; 76 loricæ.

VIII. PETALOTRICHIDÆ Kofoid and Campbell emended

Petalotrichidæ, *partim*, K. and C., (1929, p. 190) (see also the Coxliellidæ for Metacylis).

Tintinnoinea with cup- or stout goblet-shaped lorica without pedicel, and at most with only short aboral horn; circumoral structures consisting of an inner collar and outer lip or shelf with trough between, or an equivalent in circumoral shelf and oral ridge, with a suboral cone added below in Petalotricha, or with only a thin circumoral band in Wailesia; bowl short, not over 2 o.d. in length; aboral differentiation, if present, confined to aboral point or short stout horn; wall trilaminate with intermediate layer hyaline or feebly prismatic; marine, eupelagic.

Established by us (1929, p. 190) with three subfamilies, Craterellinæ, including Craterella and Acanthostomella; Metacylinæ, including Metacylis; and Petalotrichinæ, including Petalotricha. We (1929) included Metacylis in Petalotrichidæ because of similarity of its wall structure to that of other genera of this family. We now regard the annular structure as of greater systematic significance, hence now transfer Metacylis to Coxliellidæ because of spiral or annular structure of anterior region. We also add the genus Wailesia Kofoid and Campbell. Contains two subfamilies, Craterellinæ and Petalotrichinæ.

Subfamily CRATERELLINÆ Kofoid and Campbell

Petalotrichidæ with small, short, cup- or goblet-shaped lorica; circumoral region differentiated into an inner vertical collar and an outer flaring rim with a gutter or oblique slope between them; no spiral or annular structure except in *Craterella armilla* with one ring; bowl with

upper cylinder or inverted truncated cone and lower inverted cone; aboral end closed, pointed, or rounded. Contains the genera Craterella and Acanthostomella with 7 species each.

Subfamily PETALOTRICHINÆ Kofoid and Campbell

Petalotrichidæ with large, very stout goblet-shaped or subconical lorica with nuchal constriction and flaring rim; suboral region differentiated into circumoral shelf, oral ridge, and suboral cone or with only a circumoral band (in Wailesia); nuchal constriction below cone; bowl globular, saccular, or subconical; aboral end pointed or rounded or with stout aboral horn; marine, eupelagic in temperate and tropical seas. Contains the genera Petalotricha with 8 species and Wailesia with 1. Wailesia gen. nov. Kofoid and Campbell mss. is founded on the species described by Wailes (1925, p. 533, pl. 1, fig. 1) as *Dictyocysta apiculata* from the Strait of Georgia, B. C. Its type and only species is *W. apiculata* (Wailes).

17. CRATERELLA Kofoid and Campbell

Craterellinæ with very small, stout goblet- or cup-shaped lorica; circumoral region always with two rims, an inner erect or spreading collar, and an outer flaring or horizontally spreading shelf or lip, with either a trough or an oblique outer slope between them; outer rim sometimes repeated as a suboral ring; teeth absent on both rims; bowl short, very wide, hemispherical or convex inverted conical aborally; aboral end always closed, pointed, or rounded; wall trilaminate, either homogeneous or with simple prismatic structure; marine, eupelagic in polar, temperate, and tropical seas. Type species *Craterella urceolata* (Ostenfeld) K. and C., from off Greenland.

Established by us (1929) to include three new tropical species from the Expedition, *armilla*, *protuberans*, and *acuta*, the last also found by Jörgensen (1924) in Mediterranean, but called by him *Amphorella urceolata*. Four species previously distributed elsewhere were also reassigned here, viz., *C. urceolata* (Ost.) K. and C., originally described as *Tintinnus urceolatus* by Ostenfeld (1899a), later transferred to Amphorella by Ostenfeld and Schmidt (1901) and to Undella by Cleve (1901d); *C. obscura* (Bdt.) K. and C., originally described as *Cyttarocylis obscura* by Brandt (1906, 1907); and *C. torulata* (Jörg.) K. and C.

and *C. oxyura* (Jörg.) K. and C., both described by Jörgensen (1924) as species of Amphorella.

Resembles Acanthostomella in small size, general proportions, and in circumoral structures; but lacks teeth, which are invariably well developed on suboral shelf or outer rim of Acanthostomella. The wall is also simpler, more hyaline, and with less evidence of prismatic structure, except in *C. obscura*, than in Acanthostomella.

Contains 7 species, of which 3 are recorded in Expedition material; of the 7 species, 3 were new (K. and C., 1929), and of the 3, 2 were reported in Expedition material. There are 3 divergent groups of species in this genus. *Craterella obscura* stands apart in size and prismatic structure; *armilla* is divergent in its saccular bowl and doubled suboral rim; and the other 5 species can be arranged in a series including *C. tortulata, oxyura, protuberans, acuta,* and *urceolata.*

Craterella armilla Kofoid and Campbell

Plate 11, figs. 7, 10, 14

Lorica small, elongated cylindrical goblet-shaped, with two suboral rings and saccular bowl; 1.08–1.75 (1.43) o.d. Oral diameter 0.57–0.93 (0.68) t.l., or 0.77–0.87 (0.85) diameter of lower suboral ring. Collar an inverted segment of a cone (16°), 0.05 t. l., or 0.09 o.d., flat or concave laterally, and thickened basally. Suboral lip, or ring, repeated, the upper, inverted, truncate convex segment of a cone (65–80°), 0.10–0.13 t.l., or 0.17–0.20 o.d.; its diameter 1.11–1.30 (1.17) o.d. Gutter shallow between its outer rim and collar. Second or lower suboral lip is similar to upper; distance between them 0.13 o.d. Bowl below second ring 1.03–1.18 o.d. in length, 1.00–1.06 o.d. wide, stout bag-shaped, with greatest diameter at junction with second ring; subcylindrical in anterior 0.50–0.56 and aborally subhemispherical in contour. Aboral end faintly pointed. Wall with distinct, but fine, subuniform pattern of subhexagonal prisms in a single layer between inner and outer lamellæ, except in suboral rings with three layers. Outer surface often a bit irregular.

Six loricæ: L., total, 27–35 (31.3). D., oral, 20–25 (21.6), first suboral ring, 23–28 (25.3) μ. This is one of the smallest eupelagic species of Tintinnoinea.

At 5 stations, viz., at 1 and 4, respectively, in Galapagos Eddy and Drift; at 68–79 (72.6)°; 5 loricæ.

Craterella protuberans Kofoid and Campbell

Plate 11, fig. 16

Lorica small and quite wide, low goblet-shaped; 1.28 o.d. Oral diameter 0.85 t.l. Collar conical (8°), thin-walled, 0.09 t.l. Suboral ring 0.12 t.l., with diameter of 1.15 o.d., with broadly rounded outer margin. Gutter shallow, deepest against collar. Bowl below suboral lip low, blunt-pointed acorn-shaped, a little less than 1 o.d. in length, widest just below lip; an inverted segment of a convex cone (18°) in its anterior 0.4, and contracting in posterior 0.6 to an inverted, quite convex cone (90°). Aboral horn abruptly emergent, inverted conical (55°), with diameter of base equaling its height. Tip closed, broadly rounded. Wall hyaline, with very faint traces of minute primary hexagons in upper part of bowl.

L., total, 40; collar, 4; aboral horn, 5. D., oral, 35; suboral lip, 38; base of horn, 5μ.

At Sta. 4705, in Drift; at 72°; 1 lorica.

Craterella urceolata (Ostenfeld) Kofoid and Campbell

Plate 11, fig. 17

Lorica small, wide goblet-shaped, constricted below rim; 1.13–1.27 (1.21) o.d. Oral diameter 0.79–0.89 (0.83) t.l. Collar a truncated segment of a cone (8–23°) 0.10 t.l., projecting 0.8 its length above suboral lip, concave outwardly. Suboral lip a low, inverted, truncate segment of a cone (47–55°), 0.13 t.l. Diameter at junction with bowl 1.10–1.15 o.d., and on rim 1.20–1.23; convex on its oral surface. Gutter shallow, less than semicircle in cross section with subequal slopes. Bowl inverted dome-shaped, 0.8–1.0 o.d. in length, widest at its junction with suboral lip, inverted subconical (5–10°) in anterior 0.5, and subhemispherical posteriorly with broadly rounded aboral end. Wall extremely hyaline, with only a little surface mottling and faintest traces of primary prismatic structure between the thin lamellæ.

Three loricæ: L., total, 35–38; collar, 3–4. D., oral, 30–31; suboral lip, 36–38μ.

At 4 stations, viz., at 2 each in Peruvian Current and Drift; at 68–79 (73.2)°; 5 loricæ. Also from Salpa stomachs at 3 stations in Drift near outer edge of Peruvian Current.

18. ACANTHOSTOMELLA Jörgensen

Craterellinæ with very small, cup-shaped, or broadly subconical lorica; circumoral region with minute collar and suboral ring, oral margin entire; trough well-defined; suboral ring with few to many short, low, or long, triangular, spreading teeth; aboral end closed, pointed (except in *A. minutissima*), or with a short, tapering horn; wall trilaminate, with inner and outer lamellæ, and intermediate layer of well developed simple prismatic structure; marine, eupelagic, in temperate and tropical seas. Type species *Acanthostomella norvegica* (Daday) Jörgensen, originally described by Claparède and Lachmann (1858, pl. 8, fig. 16) from off Norway as Tintinnus sp. and later named by Daday (1887b, p. 543).

Established for one species, *norvegica*, by Jörgensen (1927). This species had been previously included in Tintinnus by Claparède and Lachmann (1858), Brandt (1906), Merkle (1909), and Cleve (1899a) (as *T. minutus*), in Amphorella by Daday (1887b) and Meunier (1910), and in Cyttarocylis by Jörgensen (1899, 1901, 1905). Meunier (1910) included *A. elongata* in *Amphorella norvegica*. Brandt (1896) and Vanhöffen (1897) included *A. gracilis* in Tintinnus, and Jörgensen put it in Cyttarocylis. We (1929) added to the type species, *A. norvegica*, 6 others, including Meunier's (1910) elongated form of *norvegica* as *A. elongata*, Brandt's (1896) *Tintinnus gracilis* (= *Cyttarocylis gracilis* [Bdt.]) Jörg. as *A. gracilis*, and 4 new ones of tropical origin, namely, *A. conicoides*, *lata*, *minutissima*, and *obtusa*.

Most resembles Craterella, which is also a genus of tiny, pelagic, cup-shaped Tintinnoinea, but has no teeth on suboral ring. Prismatic structure of wall is also somewhat better developed than in Craterella. Acanthostomella stands rather alone, with Craterella as a degenerate or primitive member of the Petalotrichidæ, without any significant evidence of relationship, except the similarity of its circumoral channeled rim, to that of the Rhabdonellidæ and Xystonellopsis.

Contains 7 species, of which 5 are present in Expedition material; of the 7, 5 were new (see K. and C., 1929) and all are present in Expedition material. The 7 species fall into 2 series: — *minutissima* series, including *minutissima*, *gracilis*, *norvegica*, and *elongata;* and the *conicoides* series, including *conicoides*, *obtusa*, and *lata*.

Acanthostomella conicoides Kofoid and Campbell

Plate 11, fig. 9

Lorica slender, goblet-shaped, tapering below; 2.10–2.42 (2.23) o.d. Oral margin thick, somewhat rounded. Oral diameter 0.41–0.47 (0.44) t.l. Collar a short cylinder, 0.06 o.d. in length. Suboral lip or ring a truncate, inverted segment of a cone (60–63°), 0.12–0.23 (0.15) o.d. in length including teeth, 1.50–1.56 (1.53) o.d. in greatest diameter, deeply excavated between teeth. Teeth few (7–8), spike-like, strongly curved to right (up to 63°), projecting for 0.5 their length above collar, subequidistant, slender triangular (22°) with sharp point, with base 0.25 of length. Gutter shallow, inverted, angular (23°). Bowl narrow, goblet-shaped, widest immediately below collar, 1.2–1.3 o.d. to base of aboral horn. No nuchal constriction. Upper half of bowl subconical (up to 10°), with little convexity; lower half distally a cone of 75°, with more convexity. Aboral horn solid, tapering conical (8–20°), 0.35–0.60 o.d. in length, and with basal diameter 0.25–0.80 its length. Tip bluntly pointed, closed. Wall uniformly hyaline.

Four loricæ: L., total, 31–41; aboral horn, 7–12. D., oral, 19–21μ.

At 5 stations, viz., at 1, 1, 1, and 2, respectively, in Peruvian Current, Panamic Area, Galapagos Eddy, and Drift; at 66–80 (75°); 5 loricæ.

Acanthostomella lata Kofoid and Campbell

Plate 11, fig. 20

Lorica stout, short goblet-shaped; 1.37–1.62 (1.48) o.d. Diameter of oral opening 0.62–0.73 (0.68) t.l. Collar erect, a short, ring-like cylinder, 0.12 t.l., with entire, thin margin, with straight sides and a trace of outward lateral concavity. Suboral lip 0.13 t.l., convex outwardly, with lower diameter 1.03–1.08 o.d., and greatest diameter 1.14–1.23. Teeth 20–25, subequidistant, triangular, with sharp points, not over twice as long as basal width, and directed upwardly, or sometimes inwardly; in some loricæ (Plate 11, fig. 20) with leiotropic slant, in others erect, or even slightly dexiotropic. Circumoral gutter narrow, 0.05 o.d. in width, subangular (45°), with rounded bottom, and deeper than wide. Collar projects above suboral lip and its teeth, for nearly the length of a tooth. Bowl broad, inverted, convex conical, its length to base of horn 1 o.d., widest (1.05 o.d.) at upper end, contracting evenly in its upper 0.6, changing from 10° to 40° in that distance, and more rapidly to 95° below. Aboral horn concave conical, contracting

from 45° at base with deeply concave contour to 12° distally. Its basal diameter 0.50–0.62 its length. Lumen extending into horn about half its length. Wall very hyaline, homogeneous, with several rows of small, faint subhexagonal prisms below suboral lip, and fainter suggestions elsewhere between the closely approximated single-contoured lamellæ.

Five loricæ: L., total, 27–41; spine, 5–8. D., oral, 15–27; suboral lip, 17–31 μ.

At 4 stations, viz., at 1 each in Peruvian Current and Panamic Area and 2 in Drift; at 66–80 (75)°; 4 loricæ.

Acanthostomella minutissima Kofoid and Campbell

Plate 11, figs. 1, 4–6, 13

Lorica small, stout, cylindrical goblet-shaped; 1.30–1.64 (1.45) o.d. Oral diameter 0.61–0.77 (0.69) t.l. Collar a low truncated segment of a cone (20–25°), 0.05–0.06 t.l. Gutter 0.12–0.16 and 0.06 o.d. in width and depth, respectively, subsemicircular in cross section, with steeper inner than outer slope. Suboral ring or lip 0.12–0.15 t.l. in length, and 1.05–1.09 (1.08) o.d. in diameter at top of bowl, and 1.16–1.32 (1.26) at distal ends of teeth, flattened sigmoid in outer contour and broadly rounded on outer rim. No nuchal constriction. Teeth 16–30 (24.2), curved to left (17° from vertical), and directed outwardly up to 25°, subequidistant, sharp triangular (16°), with base about 0.3 of length. Bowl 0.9 t.l., a bit wider at middle, or subcylindrical, with little change in anterior 0.5, greatest diameter, when locally developed, not exceeding 1.17 o.d. Aboral end broadly rounded, ranging in contour from hemispheroidal to convex conical (100–110°), generally less than a hemisphere, without a point. Wall filled from margin of lip to aboral end with coccoliths of *Coccolithophora pelagica* or *Umbilicosphæra mirabilis*, each enclosed in a secondary lattice of beams made of primary hexagons. When coccoliths are not present, the secondary areas are clearly defined, subregular, prevailingly hexagonal, bounded by thin reticular beams, 12 across equator and 14–18 from end to end, in single layer in wall, except in collar (3–4 layers), each enclosing 8–20 primary hexagons in 2–4 layers. Wall thicker and less regular in coccolith-bearing loricæ than in others.

Three loricæ: L., total, 30–36 (32.6). D., oral, 22–23 (22.5); outer collar, 26–31 (28.4) μ.

At 11 stations, viz., at 3 and 8, respectively, in Peruvian Current and Drift; at 68–81 (78.5)°; 18 loricæ.

Acanthostomella obtusa Kofoid and Campbell

Plate 11, figs. 3, 12

Lorica moderately slender, contracted goblet-shaped; 1.57–1.73 (1.64) o.d. Oral diameter 0.58–0.64 (0.61) t.l. Collar a ring, or short cylinder, 0.04–0.07 t.l., with flat sides, outwardly a short segment of a truncated cone of 30°, with thickened and rounded edge. Suboral lip a truncate, inverted, short segment of a convex cone (46–75°), 0.11–0.15 o.d. in length, 1.07 in diameter aborally, and 1.22 on outer rim, with evenly convex contour. Teeth 8–20 (13), stout, subdextral (80°), subequidistant, triangular (12°), with base nearly twice length, with sharp distal ends extending half way to oral rim. Gutter 0.12 o.d. in width and somewhat less than semicircular in cross section, with outer slope steeper than inner. Bowl graceful, tapering goblet-shaped, contracting below with increasing convexity; in anterior 0.38–15°, increasing to 30–35° below middle, and 80–85° in aboral region, widest (1.05–1.10 o.d.) below collar. Aboral horn short, stout, obtuse, pedicel-like, an inverted truncate cone (22–32°), 0.11–0.17 (0.15) o.d. in length. Aboral end blunt, almost truncate. Tip closed. Wall with very faint hexagonal mesh, with very thin, single-contoured inner and outer hyaline lamellæ with single prismatic layer between, except in suboral ring (4 layers). Lumen continues to end of aboral horn.

Four loricæ: L., total, 26–36 (30.2); pedicel, 2–4 (2.9). D., oral, 15–23 (16.0); outer collar, 18–28 (20.0) μ.

At 6 stations, viz., at 2, 3, and 1, respectively, in Peruvian Current, Panamic Area, and Drift; at 68–79 (72.6)°; 9 loricæ. Salpa stomachs had 31 loricæ.

19. PETALOTRICHA Kent emended Daday emended Brandt

Petalotrichinæ with bowl-shaped, sack-shaped, or conical lorica; wide horizontal, or inverted, truncated conical circumoral shelf; low angular oral ridge; flaring, inverted, truncated, conical (15–45°) suboral cone; well-defined nuchal constriction with prominent, angular internal nuchal ledge; globular, saccular to convex inverted subconical bowl; hemispherical, broadly rounded, or minutely pointed aboral end; two rows of elliptical fenestræ, circumoral in single line below oral ridge with longer axes horizontal, and subnuchal in dispersed lines with longer axes vertical; wall trilaminate with inner and outer laminæ and 1–3 layers of faint prisms; marine, eupelagic in warm temperate and

tropical seas. Type species *Petalotricha ampulla* (Fol, 1881a, pl. 1, figs. 1–3) from off Villefranche-sur-Mer in Mediterranean.

In our earlier review (1929, pp. 202–205) of Petalotricha we used as the basis of proportions in *major* alone the diameter of the oral shelf, and in the other species the true oral diameter, as in this Report.

Established by Kent (1882) for two species, *ampulla* and *spiralis* (= *Rhabdonella spiralis*), originally described by Fol (1881a) in Tintinnus. Modified by Daday (1886), who transferred *spiralis* to Undella, thus giving to the genus its present form. Bütschli (1889) shifted the genus into the synonymy of Codonella. Brandt (1907) added *P. capsa* with var. *a* = *P. indica* K. and C., and var. *b* = *P. pacifica* K. and C. He also added five varieties to *P. ampulla*. Kofoid (1915) described *P. entzi*, a dwarfed and unique form originally included by Entz, Jr. (1904b) in *P. ampulla*, and we (1929), in our reorganization of the genus, included Brandt's *P. ampulla* var. *a* based on Daday's material from Naples in *P. ampulla*, gave the name *P. serrata* to his vars. *c*, *d*, and *e*, raised *P. ampulla* var. *major* Jörg. based on Brandt's *P. ampulla* var. *b*, to specific status as *P. major* Jörg., and added one new species from the collections of the Expedition, *P. foli*.

Somewhat isolated, resembling Cyttarocylis in form, but the fundamental wall structure and surface pattern at once bar close genetic relationship between these two genera. Circumoral shelf and oral ridge are homologous with suboral lip and collar of circumoral region in Craterella and Acanthostomella; but in Petalotricha this is followed in metameric fashion by the flaring suboral cone. Wall structure of Craterella and Acanthostomella is also more nearly like that of Petalotricha than of other genera, but Petalotricha has suboral and subnuchal fenestræ, which are lacking in these two genera. The genus Wailesia has suboral lacunæ which recall somewhat similar ones in aberrant individuals of *P. foli*, but otherwise there is little in common between the two save general form of lorica.

Similarity in pattern to Codonellidæ is perhaps most significant, the main difference in suboral structure being that in Codonaria the circumoral shelf of Petalotricha is represented only by the feebly developed lip at upper end of flaring suboral cone, while the insignificant oral ridge of Petalotricha is developed in Codonaria by the very distinct truncated, elevated, conical oral rim. In Petalotricha the outer part (circumoral shelf) of the circumoral territory undergoes structural evolution, while in Codonaria it is the inner part (oral rim) which evolves. Flaring suboral cone, nuchal constriction, and rotund to pointed bowl are similar in the two genera. It appears that Petalo-

tricha and the Petalotrichidæ may be derived from the Codonellidæ.

Contains 8 species, of which 4 occur in Expedition material. Of these 4 were described by us (1929), and of the 4, 2 are present in Expedition material. Ostenfeld (1909) records Petalotricha sp., probably *P. ampulla*. Subdivided into two series: — the *entzi* series, including *entzi, major, serrata, capsa,* and *indica;* and the *pacifica* series, including *pacifica, ampulla,* and *foli.*

Petalotricha capsa Brandt

Plate 11, fig. 18

Lorica elongate, large, rather stout sack-shaped; 1.21–1.28 (1.25) o.d. Oral margin rounded, sinuous, somewhat irregularly and indistinctly toothed. Oral diameter not over 0.9 t.l. Circumoral region shaped like a deep soup plate. Circumoral shelf a short, inverted, and truncate segment of a cone (112°), 0.08–0.13 (0.1) o.d. in length, slightly concave above, and contracting aborally to 0.79–0.85 (0.83) of its diameter. Suboral cone an inverted, truncate segment of a convex cone (46–74°), 0.13–0.18 (0.16) t.l., decreasing to 0.82 o.d. at its aboral end, its sides convex outwardly. Gutters very shallow. Oral ridge low and ragged. Nuchal groove sharply and rather deeply impressed. Bowl 1.00–1.10 (1.05) o.d. in length, broadly ellipsoidal, widest (0.75 o.d.) at or near its middle, contracting anteriorly abruptly into nuchal groove. Aboral region hemispherical. No aboral angle or point. Wall somewhat uneven, not exceeding 0.05 o.d. in thickness, with 2–3 layers of prisms between the well defined inner and outer lamellæ. Prisms rounded, uneven in size, 80 across one face. Suboral fenestræ 15–20 across one face. Subnuchal fenestræ in 2–5 irregular rows, 20–75 across one face on uppermost third of bowl, circular or elliptical, with their long axes vertical or oblique, 0.02–0.10 o.d. in diameter. Wall with a brownish green tint.

Four loricæ: L., total, 116–124 (121.2); bowl, 96–106 (102). D., oral shelf, 114–120 (116); oral, 96–98 (97); nuchal, 77–80 (78.5); bowl, 83–88 (86) μ.

At 4 stations, viz., at 1, 2, and 1, respectively, in California, Mexican, and South Equatorial currents; at 69–84 (78.3)°; 8 loricæ.

PETALOTRICHA FOLI Kofoid and Campbell

Plate 11, figs. 2, 8

Lorica elongate conical, with typical Petalotricha suboral structures and wall; 2.40–3.77 (2.87) o.d., but rare dwarfed individuals only 1.78 o.d. in length. Circumoral shelf concave above, convex below, elevated 30–50° from horizontal, 0.14–0.17 diameter of oral cone. Outer margin irregularly sinuous or denticulate. Diameter at rim 1.17–1.30 (1.20) o.d. Marginal denticulations continued as slight ridges on upper surface of shelf, producing an appearance of irregular fluting. Oral ridge at base of shelf reduced to a mere roughened ledge at junction of shelf and suboral cone which marks an abrupt change of slope. Suboral cone very convex outwardly and concave on its inner face, an inverted (30–40°, rarely 60°) segment of a cone, forming 0.6 of vertical elevation of combined cone and shelf, or 0.23–0.26 (0.25) o.d., or 0.08–0.10 t.l. Inner surface marked with oblique striations continued from those of shelf. Bowl the most characteristic feature of this unique species, forming 0.9 t.l. in most loricæ, or 2.16–3.52 (2.63) o.d., and rarely as little as 1.53 o.d., or 1.85–2.88 (2.18) diameters of suboral cone, with a tapering conical or bullet-shaped contour, and bluntly rounded aboral end. Its contour varies from that of a regular cone (15–25°, rarely 30°) to a ventricose one with convex sides, or one with a bulging upper half and a contracted, pedicel-like aboral region, to a dwarfed conical form having, however, a suboral region of nearly normal dimensions. Nuchal constriction slight, greatest in the ventricose and pedicellate forms. Greatest diameter of bowl at, or very shortly below, nuchal groove, less than 0.25 diameter of suboral cone. Nuchal diameter 0.86–0.96 (0.91) o.d. or 0.70–0.96 (0.75) diameter of oral shelf. The varying development of the bowl is indicated in the fact that the diameter of the bowl midway of the total length varies from 53 to 92 (75.1) μ, or from 0.53 to 0.84 (0.71) o.d. Aboral end bluntly and irregularly rounded. Diameter near tip 0.15–0.50 o.d. Contour of tip often asymmetrical, with the irregularity extending upwards for 0.3 length of bowl. Wall distinctly that of Petalotricha in structure, though differing in a group of diagnostic characteristics. It has typical inner and outer lamellæ enclosing one layer of prisms; outer lamellæ thin, inner heavy, thick, and brownish. Wall of fairly uniform thickness throughout, slightly thicker or irregularly thickened in fundus. Prisms distinct with thick walls, rounded, 1–3μ in diameter, 100–120 across one face of bowl above subnuchal zone of

fenestræ, and more distinct in bowl than in shelf or collar, both of which have in consequence a somewhat lighter tone. Subnuchal zone of fenestræ 0.2–0.5 o.d. in width below nuchal constriction. Fenestræ of same type as in other species, that is, clear areas devoid of prisms, subcircular if small, or elliptical if large, with major axis nearly twice the minor and often turned obliquely to the right above, their extreme length not over 0.06 o.d. There is very great irregularity in this fenestrated zone, both as to its width and as to number, location, size, and uniformity of fenestræ. There are loricæ in which no fenestræ are found; others in which only a single one, or several at the most, usually larger ones, are present; others in which there is only a narrow zone of small fenestræ; still others in which there is a wide and irregular zone of intermingled large and small ones. Not infrequently isolated fenestræ or a considerable number in a zone are found on the collar also, each with its longer axis in a subvertical position. There is no suboral row of horizontally placed fenestræ at the junction of shelf and collar, as in all other species of Petalotricha. Number of fenestræ exceedingly variable, 120 across one face in wider zones being the maximum noted. In one lorica the fenestræ appear to have run together and to have fused in an irregularly lobed, thin-walled, hyaline area. This fusion seems to dispose of the possibility that these elliptical fenestræ are coccoliths, as their shape might suggest. No traces of recognizable coccolith structure have been found in the fenestræ, although this tintinnid occurs in a region of maximum coccolith abundance in the loricæ of other Tintinnoinea, as, for example, in Dictyocysta, *Codonellopsis orthoceras*, and *Codonella galea*. The most unique feature of the wall is the presence of short, slanting, sinuous lines. Optical sections show that these are due to local elevations, principally, but not wholly, localized in the outer surface. There is less irregularity in the inner surface. Their significance appears when they are considered along with certain sinuosities in the nuchal groove, with internal slanting striæ in the collar, flutings on the upper surface of the oral shelf, and also with the powerful membranelles with which Petalotricha is provided. They mark the spiral action of these membranelles during the formation of the lorica. The obliquity is slight, to the right above in the figure, not more than 35° in the collar, the region of maximum deflection; and 5–10° along sides of lorica.

There are 20, possibly as many as 24, membranelles, and one large reniform macronucleus with a spheroidal micronucleus in its recess. The lower end of the body is marked by heavy longitudinal subpellicular striæ, and on one side only by numerous short rodlets vertical

to the surface in the cortical ectoplasm, representing the attachment area.

Ten loricæ: L., total, 264–377 (301.5); bowl, 238–352 (276.2). D., oral shelf, 122–130 (126.5); oral, 100–108 (105.1); nuchal, 91–99 (95.6); midway of total length, 53–92 (75.1) μ. Two other dwarf loricæ not included in the above: L., total, 179–190; bowl, 156–164. D., oral shelf, 107–127; oral, 92–107; nuchal, 78–91; midway, 82 μ.

At 18 stations, viz., at 2, 11, and 5, respectively, in Mexican and Peruvian currents and in small numbers in Drift; at 66–83 (70.1)°; 74 loricæ.

Petalotricha major Jörgensen

Plate 11, fig. 19

P. ampulla, Hofker, 1931b, p. 377, fig. 66.

Lorica small, globular, pot-shaped; 1.03–1.13 (1.09) o.d. Oral margin sinuously uneven or barely serrate. Oral diameter 1.08–1.15 (1.13) t.l. Circumoral shelf an inverted, truncate segment of a cone (105°), 0.09 t.l., outwardly convex, with peripheral diameter of 1.18–1.28 (1.23) o.d. Its sides are sometimes flattened to a more horizontal position, as in Brandt's lorica (pl. 62, fig. 8); in some loricæ vertically wrinkled inside, with broad linear creases. Suboral cone an inverted, truncate cone (36°) 0.07 t.l., decreasing regularly to nuchal constriction, with sides convex laterally and projecting above junction with oral shelf forming oral ridge inside of shallow, rounded gutter at bottom of shelf. In the same fashion upper end of the bowl projects above the bottom of suboral cone, forming angled gutter between it and upper limit of bowl. Nuchal diameter 0.87–0.98 (1.90) o.d. Bowl spheroidal 0.84 t.l., or 0.84–0.95 (0.89) o.d. in length. Equatorial diameter 0.99–1.06 (1.03) o.d. Aboral end unmodified. Wall with light outer and heavier inner lamella, very hyaline, with faint trace of single layer of small interlamellar prisms, 200 across one face. Suboral fenestræ in one row in base of suboral shelf, 20–30 across one face, elliptical, irregular, and smaller than subnuchal ones. Subnuchal zone of fenestræ on upper bowl in a band of 2–4 large areas, or up to 5–7 small and large, clear areas, circular in form, but larger ones tending to be elliptical, with long axis subvertical, and not exceeding 0.04 o.d. in length. Wall with little or none of the brownish green color characteristic of *capsa*. Animal fills greater part of bowl, with a single large sausage-shaped macronucleus 16 by 28 μ. Hofker (1931b, fig. 66) finds at least 13 macronuclei.

Ten loricæ: L., total, 87–96 (90.9); bowl, 70–77 (74.8). D., oral shelf, 101–104 (102.9); oral, 80–87 (83.7); nuchal, 72–83 (75.6); bowl, 84–88 (86.1) μ.

There is a correlation between size and temperature. Four loricæ from 75–77° have an average length of 93.3 μ, while 6 at 81° average 91 μ.

At 26 stations, viz., at 1, 3, 2, and 20, respectively, in California and South Equatorial currents, Easter Island Eddy, and Drift; at 68–81 (75.0)°; 91 loricæ.

Petalotricha pacifica Kofoid and Campbell

Plate 11, figs. 11, 15, 21

Lorica very stout, pot-shaped; 1.05–1.30 (1.15) o.d. Oral margin irregularly sinuous, subdenticulate, or subregularly serrate. Diameter of circumoral shelf 0.93–1.03 (1.02) t.l. Collar subdivided into oral shelf and suboral cone, though not shown in Brandt's figure (pl. 62, fig. 16) (see Kofoid and Campbell, 1929, fig. 385). Oral shelf a short, inverted, truncate segment of a cone (81–92°) 0.08–1.00 t.l., with aboral diameter 0.83–0.87 (0.86) of its greatest diameter. Suboral cone an inverted, truncate segment of a cone (37–57°), 0.08 t.l.; nuchal diameter 0.89–0.97 (0.93) o.d., its sides convex and projecting above oral shelf at junction with that shelf, and likewise above bowl at junction of collar with bowl, forming a shallow, rounded gutter at each of these levels. Edge of inner lip of upper gutter minutely irregular, while that of lower is more even. Seen squarely in lateral view the contour of bowl below nuchal constriction is broadly ovoidal. Our measurements include some oblique views which somewhat reduce the length. In lateral view its length ranges from 0.93 to 1.00, its greatest diameter. Bowl widest, 0.99–1.07 (1.01) o.d., at 0.44–0.50 t.l. from oral margin. Aboral end contracted to a small, blunt, inverted broadly subconical (110–120°) point, rarely ever emergent enough to be cuspidate. Wall very heavy, subuniform in thickness with very heavy inner, and somewhat lighter outer lamella enclosing only a single layer of prisms, 80–120 across one face, somewhat rounded, uneven in size, with heavy walls. Subnuchal zone with 2–4 rows of fenestræ, with a variable number of smaller areas interspersed among larger ones, 40–70 across one face, of which 20–40 are larger (and the remainder smaller), up to 0.05 o.d. in longest diameter, circular or elliptical, with long axis tending to be vertical. Suboral row of fenestræ, 25 across one face, elliptical,

with long axes horizontal. Wall with a noticeable greenish brown tint, denser than in any other species in our material, with a very minute but definite reticulum detectable in surface view in the inner lamella.

Brandt (1907) reports a single large nucleus. We find in unstained individuals a single ellipsoidal macronucleus 16 by 20μ, with an adjacent spheroidal micronucleus 7.5μ in diameter. These findings are in contradiction to those of Entz, Jr. (1909b) of 50 macronuclei (in sections), some with attached micronuclei. It is possible that he might be dealing with sporulating, endomictic, or exconjugant stages, since such numbers of macronuclei are not wholly unknown elsewhere in the Tintinnoinea.

Ten loricæ: L., total, 100–119 (107.0); bowl, 81–98 (88.5). D., oral shelf, 106–111 (109.1); oral, 88–96 (93.4); nuchal, 78–89 (86.6); bowl, 92–97 (94.8)μ.

At 4 stations, viz., at 1 and 3, respectively, in California and South Equatorial currents; at 69–78 (75.7)°; 15 loricæ.

IX. RHABDONELLIDÆ Kofoid and Campbell

Tintinnoinea with lorica chalice-shaped, rarely bowl-shaped; oral margin never toothed, simple, or flattened with lip and gutter between inner and outer lamellæ; bowl with upper and lower cone more or less differentiated; aboral region, except in *Rhabdonella hydria,* Epirhabdonella gen. nov., and the subgenus Eurhabdonella of Protorhabdonella, prolonged in a slender aboral horn, as in the subgenus Protorhabdonella, and genus Rhabdonella; or in a pedicel, knob, and lance, as in Rhabdonellopsis. Aboral horn or lance with slender canal, sometimes open at tip; wall trilaminate, with intermediate secondary prismatic structure; longitudinal ribs or striæ present, usually with fenestræ between them; animal filling less than 0.5 of lorica, attached in lower cone of bowl; 2 macronuclei, 2 micronuclei, and 20 membranelles; marine and eupelagic in temperate and tropical seas.

Resembles the Xystonellidæ in chalice-shaped lorica, flattened and usually channeled circumoral rim, and in evolution of pedicel, knob, skirt, and lance within the family. Circumoral differentiation resembles that of Cymatocylis in having inner and outer parts with depression between, but the configuration differs in the two genera and inner margin is never toothed in the Rhabdonellidæ, bowl is tapering instead of stout, and longitudinal markings are long and continuous instead of short and interrupted. Moreover, Cymatocylis is an Ant-

arctic genus, while the Rhabdonellidæ are temperate and tropical in distribution. The stout bowls of Epirhabdonella are somewhat like those of Craterella, but they have full-length striæ, wholly lacking in Craterella.

Includes 4 genera, Protorhabdonella (4 species), with its 2 subgenera, Protorhabdonella subgen. nov. and Eurhabdonella subgen. nov.; Epirhabdonella gen. nov. (3); Rhabdonella (23); and Rhabdonellopsis (7).

20. PROTORHABDONELLA Jörgensen

Protorhabdonella, *partim*, K. and C., 1929, p. 206, figs. 391–393, 395 (for fig. 394 see Epirhabdonella).

Rhabdonellidæ with lorica short, stout, or tapering; oral margin always simple, thin, obliquely flattened on inner face, but without protruding lip and intervening gutter; bowl inverted conical, elongate or stout, with 8 to 28 vertical or spiral ribs; with or without an aboral horn; wall hyaline or with visible primary structure; eupelagic in temperate and tropical seas. Type species *Protorhabdonella simplex* (Cleve) Jörg. from Atlantic.

Established by Jörgensen (1924, p. 57) for 2 stout species, *simplex* (Cleve) and *curta* (Cleve). Kofoid and Campbell (1929) added 2 new species, *mira* and *striatura*, and included *ventricosa* (Schmidt), omitted by Jörgensen (1924) and transferred to Epirhabdonella in this Report.

Its stout species, *curta* and *simplex*, are somewhat like those of Craterella in form, but have less suboral structure and have ribs, which are lacking in Craterella. The elongated species, *mira* and *striatura*, are like those of Rhabdonella in shape, but have a narrow, flattened rim instead of a guttered one with a lip.

Includes 4 species: *curta*, *simplex*, *striatura*, and *mira*, all present in Expedition material; one only, *mira*, was new (K. and C., 1929), and one, *striatura* (=*Cyttarocylis striata* forma a *elongata* Cleve, 1901a, p. 922, fig. [3a]), was given a new name on grounds that *elongata* was a homonym (K. and C., 1929, p. 208). Subdivided into two subgenera:— Protorhabdonella subgen. nov. and Eurhabdonella subgen. nov.

PROTORHABDONELLA subgen. nov.

Protorhabdonella with short, inverted, convex conical lorica, not over 2 o.d. in length; aboral horn absent. Type species is that of the genus. Contains 2 species, *curta* and *simplex*.

EURHABDONELLA subgen. nov.

Protorhabdonella with elongated, inverted conical lorica, 5 or more o.d. in length; aboral horn present. Type species is Protorhabdonella (Eurhabdonella) *mira* K. and C. from Sta. 4701 in Drift of Eastern Tropical Pacific. Contains 2 species, *mira* and *striatura*.

Protorhabdonella curta (Cleve) Jörgensen

Plate 12, figs. 2, 7

Lorica short, convex conical, rather full above; 1.43–1.84 (1.68) o.d. Oral rim entire; circumoral region subtriangular in section, with flattened top and rounded edge with projecting angle the only trace of circumoral lip. Circumoral thickening slight, extending below rim for little more than its thickness. Bowl constituting whole lorica, slightly contracted below suboral region, expanding to 1.00–1.12 (1.08) o.d. at 0.5–0.6 o.d. below rim, and contracting aborally in a convex cone (40–50°), subacute, or slightly pedicellate. Aboral end blunt, closed. Wall very thin, uniform in thickness throughout, except for increase in suboral region; exceedingly hyaline, slightly greenish yellow in color, with no trace of prisms. Ribs 18–24 (19.7), extending from aboral end to circumoral region in a left spiral course increasing in upper 0.3 of bowl to 30–45°, rather elevated, equidistant, without bifurcations or anastomoses. Intercostal regions in end view presenting a concave, fluted appearance on outer surface. No fenestræ seen. Body of animal nearly filling lorica; one macronucleus observed.

Eight loricæ: L., total, 37–48 (41.5). D., oral, 20–28 (24.6); greatest, 22–28 (26.7) μ.

At 7 stations, viz., at 2, 1, 1, 1, and 3, respectively, in California, Peruvian, and North Equatorial currents, Panamic Area, and Drift; at 71–83 (76.7)°; 17 loricæ.

Protorhabdonella mira Kofoid and Campbell

Plate 12, fig. 10

Lorica very slender, very elongate, attenuate chalice-shaped; 9.4 o.d. Oral margin entire, rounded, not guttered. Circumoral thickening 0.03 o.d. in width, and length not over twice its width. Bowl 3.6 o.d. in length, or 0.37 t.l. Its upper 0.7 subconical (3°), passing gradually into a cone of 20° forming aboral 0.3, which in turn passes imperceptibly into pedicel below. Pedicel very much elongated, 5.8 o.d. in length,

or 0.63 t.l., with upper diameter 0.07 its length; a tapering slender cone (3°) deflected 10° from vertical axis. Aboral end acute, with closed tip. Ribs 12, subvertical, inclined to right on lower bowl, very faint, subequally spaced. No fenestræ.

L., total, 235; bowl, 90; pedicel, 145. D., oral, 25; top of pedicel, 10μ.

Suggests *Albatrossiella filigera* or *A. agassizi* in form, but differs in presence of ribs, lack of collar, and size, being nearly twice as long as *A. agassizi* (127μ). Superficially like *Xystonella longicauda*, but has a different wall structure.

In *Protorhabdonella mira* there is exhibited an example of remarkable convergence in form between two distantly related but astonishingly similar forms of lorica. The loricæ of this species resemble in form and proportions those of Albatrossiella of the Tintinnidæ, but differ fundamentally in wall structure. Such convergences in form between distantly related pairs of species, as, for example, the above-mentioned pair and the similarly striking case of *Stelidiella fenestrata* and *Xystonellopsis ornata* must be of fundamental significance. They may be expressions of genetic factors emerging in widely separated species in the somewhat uniform oceanic environment. The elongation of the lorica is an adaptation to flotation in both.

At Sta. 4681 and 4701 in Drift; at 68–72 (70)°; 3 loricæ.

Protorhabdonella simplex (Cleve) Jörgensen

Plate 12, fig. 3

Lorica stout, anteriorly convex, conical vase-shaped, without a pedicel; 1.58–1.85 (1.71) o.d. Oral margin entire, rounded. Oral diameter 0.50–0.54 t.l. Circumoral thickening not over 0.07 o.d. in length, 0.05 in thickness, encroaching inwardly upon lumen without external bulge to form a suboral lip. Bowl stout, subconical bullet-shaped, widest (0.20–0.25 t.l.) below oral rim, gradually expanding to 1.07–1.20 (1.10) o.d.; above this level a truncated segment of a cone (25°) contracting symmetrically below to an inverted convex cone with distal angle of 50–70°. Aboral end closed, acutely pointed. Wall thin, bilaminate, hyaline, of greenish tinge and uniform thickness except in thicker suboral and aboral ends. Two lamellæ apparently fused, except in suboral region; intermediate layer of prisms not detected except for a faintly mottled appearance. Ribs 7–9, running longitudinally from aboral end to suboral region. Intercostal surfaces outwardly flattened, giving a faceted contour to lorica.

Ten loricæ: L., total, 47–64 (53.2). D., oral, 26–33 (31.2); greatest, 28–36 (34.4) μ.

At 42 stations, viz., at 4, 4, 9, 1, 5, 3, and 16, respectively, in California, Mexican, Peruvian, and South Equatorial currents, Panamic Area, Easter Island Eddy, and Drift; at 65–84 (75.8)°; 77 loricæ.

Protorhabdonella striatura Kofoid and Campbell

Plate 12, fig. 6

Lorica slender, conical chalice-shaped, with a short pedicel; 4.72–5.69 (5.13) o.d. Oral margin entire, rounded, not guttered. Circumoral thickening not over 0.05 o.d. in thickness, fading out gradually within a length of three times its thickness, and flaring outwardly to extent of increase in thickness. Bowl 2.42–3.11 (2.73) o.d., or 0.42–0.64 (0.53) t.l. in length, divisible into an upper section forming a segment of an inverted cone (6–10°), constituting 0.6–0.9 of bowl, and a lower one, a segment of an inverted cone (15–24°) forming 0.1–0.4 of bowl. Pedicel only slightly differentiated from bowl, forming 0.36–0.58 (0.47) t.l., 1.77–3.27 (2.44) o.d. in length, an inverted cone (7–12°) with an upper diameter 0.16–0.23 its own length. Aboral end acute or slightly rounded, with a closed tip. Wall sometimes irregular in contour but uniformly 0.02 o.d. in thickness, increasing to 0.03 in suboral region, made up of inner and outer subequal, relatively thick lamellæ, enclosing a single layer of minute prisms. Lamellæ fused toward aboral end for a length of 0.9 o.d. Prisms very faint, 3–6 across one intercostal space and about 100–150 across one face of bowl. Fenestræ present, but limited to a few scattered, tiny, ellipsoidal areas on lower end of bowl. Ribs subvertical, inclined slightly to right aborally in some loricæ, with a short sinistral deflection on suboral thickening, 28–44 in number, very faint, somewhat irregular, subequally spaced, and bifurcating occasionally on upper bowl.

Ten loricæ: L., total, 125–165 (137.4); bowl, 65–85 (73.1); pedicel, 48–95 (65.4). D., oral, 25–29 (26.8) μ.

There is some correlation of size with temperature as indicated in the relatively stouter loricæ from the cooler waters of the Peruvian Current. Prisms are somewhat more distinct in these loricæ.

At 11 stations, viz., at 3, 1, and 7, respectively, in Peruvian Current, Galapagos Eddy, and Drift; at 67–79 (73.1)°; 17 loricæ.

21. EPIRHABDONELLA gen. nov.

Rhabdonellidæ with a thin-walled circumoral crest arising from center of rim of thickened suboral region, formed by closely appressed inner and outer lamellæ; suboral lip undeveloped; well developed, thickened suboral zone and inner nuchal ridge present; bowl conical; ribs elevated as low fins; no pedicel; in tropical oceanic seas. Type species *Epirhabdonella coronata* sp. nov. from surface at Sta. 4704 in Drift.

Includes three species, *coronata* sp. nov., *mucronata* sp. nov. from Expedition material, and *ventricosa* (Schmidt), originally described (1901) as *Cyttarocylis ventricosa* from Red Sea. The last named included by Brandt (1907) in Rhabdonella and by K. and C. (1929) in Protorhabdonella. The three species differ in proportions and type of aboral end.

Differs from Protorhabdonella in addition of oral crest to circumoral region; from Rhabdonella and Rhabdonellopsis in crested instead of flattened and guttered oral rim and in absence of aboral pedicel, or of pedicel, knob, and horn. Its aboral end has not undergone structural evolution.

Epirhabdonella coronata spec. nov.

Plate 12, figs. 8, 9

Lorica slender, tapering vase-shaped, rotund anteriorly and conical posteriorly; 2.05 o.d. Oral margin rounded, entire. Oral diameter 0.5 t.l. Oral crest a short segment of an inverted, concave cone (35°), 0.08 o.d. in length, concave outwardly, rising from middle of thickened rim. Suboral lip slight, a nuchal shoulder formed on outer side of base of oral crest, not protruding beyond symmetrical contour of bowl. Suboral thickened zone 0.33 o.d. in length, with maximum thickness 0.16 its length somewhat above its middle, its uppermost inner corner projecting into lumen as a narrow, rounded nuchal ridge at upper limit of bowl. Inner nuchal diameter 0.92 o.d. Bowl pointed bullet-shaped, 1.94 o.d. in length, widest (1.1 o.d.) at 0.4 o.d. below oral margin; a segment of a convex cone (17°) above for 0.14 its length, contracting below quickly to a symmetrical cone of 40°. Aboral end bluntly rounded. Ribs 9, equidistant, uniformly vertical, running from nuchal shoulder to aboral end, each a raised fold or angled thickening of outer lamella, highest a short distance below equator of bowl, decreasing in height in both directions. Interspaces flattened, slightly concave outwardly. Wall in oral crest formed by appressed heavy inner and outer

lamellæ, between which intermediate prisms are flattened almost to extinction. In thickened suboral zone the prisms in 3 layers in widest part, decreasing distally to 1 at its aboral limit, beyond which they can be traced only in surface view; 10 across one interspace at equator.

Two loricæ: L., total, 73. D., oral, 35; greatest, 39μ.

At 3 stations, viz., at 2 and 1, respectively, in California Current and Drift; at 69–76 (72.6)°; 3 loricæ.

Epirhabdonella mucronata spec. nov.

Plate 12, figs. 13, 14

Lorica elongated, convex conical goblet-shaped, resembling that of *Protorhabdonella simplex* in proportions; 1.52–1.57 o.d. Oral margin entire. Oral diameter 0.57–0.60 t.l. Circumoral crest very low, erect, not over 0.03 o.d. in height. Nuchal shoulder prominent, representing suboral lip. Inner nuchal ridge broadly rounded. Nuchal diameter a trifle less than oral. Suboral thickened zone narrow, 0.15 o.d. in length and 0.05 in thickness, encroaching upon lumen. Bowl below nuchal shoulder broadly bullet-shaped, 1.49–1.54 o.d. in length, widest (1.05–1.12 o.d.) within 0.25 t.l. below oral margin, forming above this level a segment of a convex cone (33–37°), and below, an inverted convex cone changing gradually from 23° near middle of bowl to 60–65° aborally. Aboral end abruptly contracted to an almost truncated end 0.15 o.d. in diameter, with a minute, mucronate aboral point in center. Ribs 9, equidistant, vertical, running from nuchal region to flattened aboral end. Wall very thin, hyaline, thicker in suboral zone.

Two loricæ: L., total, 53–55. D., oral, 28–32; greatest, 85μ.

At Sta. 4576 in California Current; at 69°; 2 loricæ.

22. RHABDONELLA Brandt emended Kofoid and Campbell

Rhabdonellidae with elongate, striate, chalice-shaped lorica; oral margin entire, always lacking teeth, with a more or less clearly defined gutter between inner and outer lamellæ, inner usually a bit higher than outer, projecting as a suboral lip; bowl conical, except in the aberrant *anadyomene, hydria,* and *poculum;* aboral horn gradually differentiated from bowl, slender, more or less protracted, never with apophyses, knob, skirt, or lance; ribs numerous (20–64), subvertical, simple, or branched, sometimes with anastomoses; fenestræ none, or few to many between ribs, especially in suboral region; wall trilaminate, with inner

and outer double-contoured lamellæ well developed, especially suborally, with one layer of primary prisms in them, prominent secondary prisms in intermediate layer between, each filled with smaller primary ones. Type species *Rhabdonella spiralis* (Fol) Bdt. emended K. and C. from Mediterranean off Villefranche-sur-Mer.

Established by Brandt (1907) as a subgenus, but with vacillation given generic standing in the same monograph. Laackmann (1909) accorded it generic rank. Jörgensen (1924) accepted its generic status, and, by the withdrawal of Protorhabdonella, assisted greatly in its clarification. We (1929) accepted Jörgensen's Protorhabdonella, and by the removal of Rhabdonellopsis with a knobbed pedicel still further increased the homogeneity of the genus.

Resembles Rhabdonellopsis, except that it has a simple aboral horn instead of distinct pedicel, apophysis, and knob, skirt, and lance. Differs from Protorhabdonella in having a guttered circumoral rim, and from Epirhabdonella in a distinct aboral horn.

Includes 23 species, of which 19 are present in Expedition material. Of these 23 species 9 were new and 1 other is assigned a new name (K. and C., 1929, p. 213). All 9 species are present in Expedition material.

The species fall into two quite homogeneous but intergrading groups, the *exilis* and *torta* series.

The *exilis* series includes 9 species, as follows: — *exilis, indica, amor, cornucopia, brandti, elegans, quantula, inflata,* and as an aberrant member, *poculum.*

The *torta* series includes 13 species, as follows: — *torta, striata, valdestriata, hebe, henseni, chavesi, spiralis, aberrans, lohmanni, cuspidata, conica,* the dwarfed *chiliensis,* and the aberrant *anadyomene.*

Rhabdonella anadyomene Entz, Sr. (1884) is questionably a tintinnid. It was found but once at Naples and has never since been reported. *R. hydria* is regarded by Jörgensen as "accidental", but it occurred at 18 stations in the Mediterranean and was quite variable. Should it prove to consist of normal loricæ the species should not remain in Rhabdonella, as it lacks the characteristic aboral horn, and a new genus should be erected for it if and when its normality is established. Possibly it represents a complex of species. *R. chiliensis* occurred at 3 stations, is a depauperate or dwarfed species, and clearly belongs in the *R. torta* series, though abnormally small.

Rhabdonella aberrans Kofoid and Campbell

Plate 14, fig. 7

Lorica greatly elongated, very slender chalice-shaped, its bowl and horn subequal, merging gradually; 7.41 o.d. Oral rim not projecting above shelf. Oral diameter 0.13 t.l. Circumoral shelf 0.16 o.d. in width, diameter to margin of lip 1.32 o.d. Circumoral gutter slightly concave, sloping to oral margin. Lip with an irregularly crenate margin, flaring very abruptly, with a sigmoid outline underneath, and a height of 0.1 o.d. Bowl and horn, respectively, 0.53 and 0.47 t.l. Bowl tapering conical, subcylindrical above, tapering below gradually into horn, divisible into approximately equal upper and lower cones, upper 5° increasing below to 10°, lower nearly conical (20°), passing gradually into horn. Aboral horn crooked, subconical (3°), somewhat twisted, with truncate end and obscure minute canal to tip, with upper diameter 0.06 its length, with no optically differentiated knob region, except for somewhat larger prisms in lower horn. Wall nearly uniform in thickness throughout lorica below suboral ridge, increasing in suboral shelf, and thinning out in lower bowl, trilaminate, enclosing one layer of prisms, increasing to 2–8 in uppermost bowl and suboral shelf, about 75 across one face. Ribs deficient, vanishing at about 1.0 o.d. below rim, and not reappearing, except for two oblique ribs crossing upper horn in an ascending left spiral (18°), and reappearing faintly on the lower horn, 30 at top of lorica, bifurcating widely below shelf, showing interruption, interpolation, anastomoses, feeble development, and minutely sinuous courses. Fenestræ scattered, elliptical, with long axis vertical, extending on upper horn, 8–12 in one intercostal space, with long diameter of 2μ.

L., total, 400; bowl, 212; horn, 188; D., oral, 54; suboral shelf, 71μ.

At Sta. 4580 in California Current; at 76°; 1 lorica.

Rhabdonella amor (Cleve) Brandt

Plate 12, fig. 5

Lorica moderately elongate goblet-shaped, convex conical, without distinct horn; 1.97–2.88 (2.29) o.d. Bowl constitutes whole lorica and bears only a moderately defined suboral shelf. Oral rim low, flaring less than 3°, barely emergent above lip. Oral diameter 0.35–0.50 (0.44) t.l. Suboral shelf 0.11 o.d. in width, diameter to edge of lip 1.14–1.26 (1.19) o.d., its upper surface sloping obliquely to base of oral rim, form-

ing a shallow gutter triangular in section, lower surface of lip slightly convex, merging in bowl within 0.15 o.d. Bowl scarcely divisible into upper and lower cones; its upper 0.5–0.6 convex subconical (5–15°) and lower 0.5–0.4 a regular convex cone (45–60°). Aboral point acute, closed. Wall thin, thickening in suboral region and not in pedicel, subject to local thinning around fenestræ, composed of two lamellæ enclosing 1–2 layers of minute, regular, uniform prisms, increasing to 6 in suboral shelf, somewhat larger in uppermost part of bowl, 5–7 prisms across one intercostal space and 150–180 across one face of bowl. Ribs well defined, extending from aboral end to suboral shelf, terminating on its under surface, slightly spiral, ascending to left 5–10°, increasing to 20–60° just below shelf, subequidistant, sometimes incomplete or interpolated, and often sinuous on lower bowl, bifurcating near mid-bowl and anastomosing to left or right, anastomoses sometimes faint, and bifurcations near shelf rare. There are 24–36 (30) ribs, according to both our and Jörgensen's (1924) observations. Fenestræ small, inconspicuous, and numerous in our loricæ, decreasing in frequency towards shelf, 30–50 in one intercostal space, irregularly distributed, often near ribs, and extending well towards aboral end, circular, variable in size (1.5–2.5μ), not thick-walled, less prominent than in *spiralis* and *valdestriata*. There are 2 ellipsoidal macronuclei, 8 by 11μ, with 2 adjacent micronuclei, 3 by 4μ, and 20 membranelles, approximating ribs in number. Body nearly fills lorica.

Ten loricæ: L., total, 77–107 (90.1). D., oral, 37–42 (39.3); oral lip, 45–49 (46.8)μ.

Loricæ from warmer (76–84°) record stations are somewhat smaller (86μ) than those (99μ) from colder (72–73°) ones. However, the longest lorica (107μ) is from 76°.

At 60 stations, viz., at 3, 9, 3, 1, 1, 13, 2, and 28, respectively, in California, Mexican, Peruvian, and South and North Equatorial currents, Panamic Area, Galapagos Eddy, and Drift; at 66–85 (77.5)°; 526 loricæ.

Rhabdonella chiliensis Kofoid and Campbell

Plate 14, fig. 8; Plate 15, figs. 10, 16, 17

Lorica medium tall, very tapering chalice-shaped, with short bowl and long horn; 5.0–5.3 (5.2) o.d. Oral rim erect, no higher than lip, less than 0.02 o.d. in height. Circumoral shelf with width of 0.1 o.d., and diameter to margin of lip of 1.16–1.28 o.d. Oral diameter 0.2 t.l. Cir-

cumoral gutter a concave depression on shelf. Lip angled (60°), with rounded, undulating edge due to deflected ribs which fade out at its upper surface, its contour contained within an inverted cone of 65°, suboral thickening not exceeding 0.11–0.25 o.d. in height. Bowl and horn, respectively, 0.56–0.60 (0.59) and 0.44–0.40 (0.41) t.l. Bowl 3.0 o.d. in length, with upper cone (6–10°) 0.66 length of bowl, and lower (25–28°) 0.33. Transition to horn better defined than in other species. Aboral horn 2.0–2.8 o.d. in length, subconical 10° above, slightly curved asymmetrically, subcylindrical below, expanding a little in fusiform knob with localized expansion in central canal 0.5 o.d. above tip, tapering (8–10°) below. Tip truncate, minutely open. Wall hyaline, slightly tinged with yellow, rather thick, thinning below shelf, in lower bowl, and upper horn, thickening in shelf and knob, trilaminate, with thin lamellæ enclosing one layer of prisms, increasing to 2–4 in shelf, thin-walled, minute, faint, 8–10 between ribs, and 150–160 across one face, somewhat larger near rim and in lower horn. Ribs 48–60, subvertical in direction, with a slight right spiral on knob, and with some sinistral suboral deflection, but not so much as in *chavesi*, extending from rim to tip, but crowded and faint on horn, indistinct, bifurcating freely, with resulting crowding in upper 0.3 of bowl, with many anastomoses, approximations, and refusions. Fenestræ 13–20 between ribs on bowl, extending from 0.27 of its length below rim to at least below knob, irregularly subcircular, flaring inwardly, with area around them not externally impressed, irregularly submedian in location between ribs, and growing smaller and more elliptical in narrow spaces on horn.

Three loricæ: L., total, 270–296 (283.3); bowl, 162–176 (167.3); pedicel, 108–130 (119.3). D., oral, 54–56 (55.0); lip, 64–67 (65.2); midway, 23–29 (26.6); knob, 5–7 (5.7) μ.

At 3 stations, viz., at 1 and 2, respectively, in California and Peruvian currents; at 66–71 (68.3)°; 4 loricæ.

Rhabdonella conica Kofoid and Campbell

Plate 14, figs. 2, 10, 11

Lorica very tall, tapering chalice-shaped, with slender bowl, very long horn; 5.6–7.9 (6.7) o.d. Oral rim erect or slightly flaring, thicker than inner lamella from which it springs, and not higher than suboral shelf, encroaching slightly on lumen. Oral margin gently, irregularly

undulating. Oral diameter 0.13–0.18 (0.15) t.l. Circumoral gutter shallow, sloping (15°) up to rim. Circumoral shelf 0.1 o.d., and diameter to margin of lip 1.14–1.21 (1.19) o.d. Lip thick, somewhat undulating, angled (75°), with rounded edge and under surface flaring abruptly (45°) and merging at once into wall within 0.14–0.20 o.d. of margin. Bowl and horn, respectively, 0.43–0.56 (0.51) and 0.57–0.44 (0.49) t.l. Bowl 2.9–4.0 (3.4) o.d. in length, only approximately divisible into upper and lower cones; upper 0.67–0.78 (0.72) length of bowl, with angle of 5–14°; lower 0.22–0.33 (0.28), with angle of 15–25°. Transition of lower cone to horn gradual, except in wider-angled bowls. Aboral horn a subregular, elongated, concave cone decreasing from 10° above to 2–3° towards lower end, and increasing abruptly near tip to 10°, 2.5–4.5 (3.3) o.d. in length, with upper diameter 0.08–0.13 its length, without an optically differentiated region corresponding to knob, though some loricæ have a slight distal enlargement of prisms. Tip abruptly truncate and minutely open. Wall thin, hyaline, of a light straw color, decreasing aborally in thickness from shelf to midbowl and lower horn, trilaminate, with equal lamellæ of medium thickness, enclosing 1 layer of very regular, uniform, and fairly distinct prisms, increasing to 2–5 in shelf, largest and most distinct in shelf, decreasing slightly aborally, and enlarged in lower horn, 6–8 between ribs and 95–120 across one face. Ribs 32–48 (39), very distinct, even to lower horn, and sometimes to its very tip, less regular, less equidistant, and less straight in our loricæ than in Brandt's figures, subject to minor sinuosities, irregularities, approximations, occasional interpolations and coalescences, and frequent sinistral, ascending anastomoses. Bifurcations most numerous on lower part of lower cone and near shelf. Course of the ribs varying in obliquity in a more or less sinistral (5–12°) spiral, becoming subvertical towards top and often terminating in short, abrupt sinistral turn, up to 20°, less oblique in long bowls than in shorter ones, greatest in transition region and lower cone, vertical on horn, though dextrally spiral in knob region. Fenestræ 13–20 (17) in one intercostal space on bowl, 0.3–0.5 of intercostal space in diameter, circular or very broadly elliptical in outline, becoming narrowly elliptical in horn with long axis vertical, flaring inward, very distinct, subuniform in shape, and distributed subuniformly beginning 0.4 o.d. below rim and extending well towards lower end of horn in reduced frequency and size.

Ten loricæ: L., total, 290–452 (364.5); bowl, 153–216 (185.6); pedicel, 137–255 (178.9). D., oral, 52–57 (54.9); lip, 63–69 (65.4); midway, 11–28 (18.3) μ.

At 19 stations, viz., at 2, 7, 3, 2, 2, and 3, respectively, in California, Mexican, Peruvian, South Equatorial, and Equatorial Counter currents, and Panamic Area; at 66–85 (78.9)°; 221 loricæ.

Rhabdonella cornucopia Kofoid and Campbell

Plate 12, figs. 1, 12

Lorica distinctly conical (18–36°) vase-shaped; 2.16–3.46 (2.91) o.d. Oral rim thin, forming a truncated segment of a cone (27°) extending 0.07 o.d. above suboral shelf. Oral diameter 0.29–0.46 (0.34) t.l. Suboral shelf flattened concave above, 0.11 o.d. in width, diameter to lip 1.10–1.25 (1.16) o.d. Lip angled (55°), its edge rounded, and its height equalling that of oral rim. Bowl conical (22–30°), 1.71–2.41 (2.05) o.d. in length, with no division into upper and lower parts, except for a slight increase in angle of cone in its lower 0.35, forming 0.67–0.79 (0.72) t.l., and passing more or less abruptly into aboral horn, which forms 0.21–0.34 (0.29) t.l. and is 0.44–1.18 (0.82) o.d. in length, with basal diameter of 0.25 o.d., subcylindrical to subconical (6–8°), tapering more in its distal 0.3–0.4 to a truncate open or blunt tip, whose diameter is 0.3–0.5 that at base of horn, often with a slight expansion at 0.4 of length of horn from its tip but with no internal expansion of canal. This slight expansion represents the knob region of Rhabdonellopsis. A narrow canal of uniform calibre (0.25–0.33 of that of horn) passes from lumen of bowl to open tip. In some loricæ the tip appears to be closed. Wall of nearly uniform thickness, thickening at circumoral rim and less in horn, exceedingly hyaline, with faint prismatic structure and striæ, trilaminate, the two lamellæ enclosing on bowl a single layer of radially disposed, regular, uniform prisms, larger below suboral shelf, with 3–4 layers of smaller prisms and 2–4 layers of larger, more distinct ones in denser lemon-yellow horn, 50 across one face in suboral zone of large prisms, 65 below this, and 8–12 on horn. Ribs very faint, best seen in upper 0.3 of bowl and below suboral shelf, subvertical, with inclination not exceeding 10° to left. Bifurcations vary in number, with variations from 20 to 30 in number of ribs at upper end of bowl. Ribs cannot be traced upon horn. No fenestræ seen. About 20 membranelles.

Ten loricæ: L., total, 97–146 (124.9); bowl, 77–106 (89.2); horn, 20–49 (35.7). D., oral, 39–46 (43.6); lip, 43–55 (50.6); pedicel, 4–6 (4.8) μ.

At 27 stations, viz., at 2, 3, 2, 4, and 16, respectively, in California, Mexican and South Equatorial currents, Panamic Area, and Drift; at 69–84 (77.9)°; 170 loricæ.

Rhabdonella cuspidata (Zacharias) Brandt

Plate 15, figs. 3–5

R. gigantea K. and C., 1929, p. 212. *Lapsus pennæ* in the use of a discarded manuscript name.

Lorica large, extremely tall, chalice-shaped, with horn shorter than long, laterally concave bowl; 6.3–9.3 (7.5) o.d. Oral rim and circumoral shelf like those in *spiralis*, except that rim is better developed, gutter somewhat deeper, and shelf more abruptly emergent. Oral rim not exceeding 0.025 o.d. in height, suberect, and thickened. Oral diameter 0.11–0.16 (0.13) t.l. Circumoral gutter sloping 15° down to oral rim with flat bottom. Width of shelf 0.09 o.d., and diameter to its edge 1.09–1.24 (1.17) o.d. Lip with slope of 30° on lower surface and crenulated or undulating edge. Bowl and horn, respectively, 0.49–0.75 (0.61) and 0.51–0.25 (0.39) t.l. Length of bowl 232–389 (271) μ, a distinguishing feature of the species, exceeding that in all other species of genus. To this is added concavity of lateral contour in upper third of bowl, which is very pronounced in some loricæ and scarcely detectable in others. The extreme depth of this, 0.12 o.d., measured to subtending tangent, gives a baggy appearance to lower bowl, which varies greatly in development, from slightest expansion, only 0.75 o.d., up to 1.00. Loricæ with least expansion vary toward *spiralis*. Bowl readily divisible into upper and lower cones, upper with angle of 0–5°, 0.58–0.80 total length of bowl; lower conical or convex subconical (18–25°), 0.20–0.42 length of bowl, narrower ones having least concavity above. Transition to horn gradual. Aboral horn concave conical, much elongated, 2.0–4.1 (2.19) o.d. in length, its angle above 15–20°, decreasing to 5–0° distally, and increasing again to about 10° near end, its upper diameter 0.07–0.20 its length, sometimes curved, bent, or asymmetrical. Tip truncate, open. Wall heavier than in *spiralis* by reason of the thick lamellæ, hyaline, of a bright straw color, thickest in shelf, decreasing abruptly below in lower bowl, and in horn, trilaminate, with heavy lamellæ, inner heavier than outer, enclosing a single layer of prisms, increasing to 2–4 in shelf, largest at edge in shelf, decreasing aborally, uniform, regular, very faint, hyaline, larger and clearer in lower horn, 5–8 between ribs and 150 across one face. Ribs 48–72

(58.5), running from crenations in shelf far down on horn, rather sinuous, with minor irregularities, not regularly equidistant, frequently anastomosing, coalescing, or reuniting, and bifurcating on lower bowl and occasionally above, but rarely in suboral region, interpolations occurring in some loricæ nearly as frequently as bifurcations, their course an ascending left spiral, steepest (20°) on lower bowl, continuing steeply through middle, and becoming subvertical above, with or without a sinistral turn at top. Fenestræ very prominent, with thick walls flaring inwardly, submedian in intercostal space, 15–25 in one space, beginning about 0.3 o.d. below rim and continuing far down on horn in smaller size and reduced numbers, very broadly elliptical with long axis vertical, or circular with a diameter of 0.3–0.4 intercostal space. Several instances of doubled fenestræ, two openings in one encircling wall (Plate 15, fig. 3), were seen.

Ten loricæ: L., total, 404–520 (446.7); bowl, 232–389 (270.5); horn, 125–242 (176.2). D., oral, 56–64 (59.8); lip, 66–72 (69.8); midway, 26–60 (35.5) μ.

At 25 stations, viz., at 8, 12, and 5, respectively, in Mexican and Peruvian currents and Panamic Area; at 66–85 (75.2)°; 62 loricæ.

Rhabdonella elegans Jörgensen emended Kofoid and Campbell

Lorica short, conical chalice-shaped; 3.53–4.14 (3.88) o.d. Brandt's (pl. 54, figs. 3, 11) loricæ measure 2.72–3.11 (2.92) and may be flattened. Oral rim scarcely emergent, forming a segment of an inverted cone (22°) less than width of suboral shelf in height. Oral diameter 0.28–0.32 t.l. Suboral shelf less than 0.1 o.d. in width, diameter to its edge 1.15 o.d. Circumoral gutter angular (50°), deepest (0.5 its width) next to oral rim. Suboral lip but little developed or angled outwardly. Suboral thickening (0.1 o.d.) tapering aborally for 0.34 o.d. Bowl 0.68–0.70 t.l., 2.15–2.28 o.d. (2.14–2.37 o.d. in Brandt's loricæ), roughly divisible into upper subcylindrical to subconical (4–20°) cone forming 0.6–0.7 length of bowl, and lower one of less convexity and wider cone (35–45°) forming 0.4–0.3 of bowl with a gradual transition between. Aboral horn 1.02–1.08 o.d. in length, tapering conical (10–15°), with upper diameter 0.2–0.4 its length and with acute or blunt closed tip. Wall uniform in thickness, thickening in suboral shelf, but not in horn, composed of two subequal lamellæ enclosing 2 layers of very fine and faintly outlined, subregular, uniform prisms, increasing to 3–5 in suboral shelf, 8–12 across one intercostal space and 200 across

one face of bowl. Ribs vertical throughout most of their course, turning abruptly to left (30–40°) below suboral shelf and fading out on its slope, 36–48, subequally spaced and somewhat irregular in their course, bifurcating frequently on lower and middle parts of more flaring bowls, with few anastomoses and coalescences. Fenestræ small, circular, rather faint, irregularly distributed, 20–30 in one intercostal space, varying in size from 0.5 to 1.2μ and distributed from a short distance below shelf well down upon the horn. Body bell-shaped, with peduncle attached in lower end of bowl. Animal nearly fills bowl.

Two loricæ: L., total, 149–180; bowl, 101–125; horn, 48–55. D., oral, 47–51; oral lip, 54–59μ.

At 3 stations, viz., at 2 and 1, respectively, in Panamic Area and Drift; at 69–80 (76.3)°; 4 loricæ.

Rhabdonella exilis Kofoid and Campbell

Plate 12, fig. 4

Lorica tapering conical goblet-shaped, with sinuous outline; 2.22–2.60 (2.46) o.d. Circumoral shelf not abruptly nor widely flaring, with width and diameter to margin of lip, respectively, 0.11 and 1.12–1.19 (1.17) o.d., its upper surface slightly channeled by a gutter flattened semicircular in cross section. Suboral lip entire, with rounded outer angle and slightly convex outline below. Oral rim abruptly flaring, very low, with thin edge formed by projecting inner lamella. Bowl inverted, slightly convex conical, its angle increasing from 10–15° in upper bowl to 35–45° in its lowermost part without localized transition; forming 0.72–0.80 (0.77) t.l., or 1.74–2.16 (1.92) o.d. Aboral horn tapering conical (12–25°), sharply set off from bowl by abrupt change in slope, its length 0.20–0.28 (0.23) t.l., diameter at upper end 0.13–0.18 o.d. Tip acute, closed. Wall uniform in thickness throughout, except in expanded suboral region (triangular in section); not thickened in aboral horn; visibly trilaminate only in suboral region, two lamellæ completely fused elsewhere into a single, thin, homogeneous, hyaline, greenish-yellow layer in which prisms are not demonstrable, even in suboral thickening. Ribs 45, feebly developed, scarcely affecting lateral outline, demonstrable in surface view only under best conditions of definition; running from edge of shelf downwards, fading out on aboral horn; ascending spirally to the left 8–10°, increasing to 25° just below rim, fairly regular, nearly equidistant, bifurcating occasionally, and anastomosing frequently, the anastomosing branch passing generally to right. No fenestræ found.

Eight loricæ: L., total, 60–70 (63.1); bowl, 43–54 (49); aboral horn, 12–17 (14.1). D., oral, 24–28 (25.6); oral lip, 27–33 (29.9) μ.

At 7 stations, viz., at 1, 2, and 4, respectively, in California and Peruvian currents and Drift; at 68–83 (73.9)°; 11 loricæ.

Rhabdonella hebe (Cleve) Brandt.

Plate 13, figs. 7–9, 11, 12

R. amor, Alzamora, 1929, p. 9, fig. 19.

Lorica of moderate length, short-bowled, conical chalice-shaped; 4.1–5.1 (4.4) o.d. Oral rim very low, not over 0.04 o.d. in height, forming a low segment of a cone of 10°. Oral diameter 0.20–0.24 t.l. Circumoral shelf wide, 0.14 o.d. in width, and diameter to outer margin of lip 1.25 o.d. Circumoral gutter shallow, angular, deepest against oral rim. Lip angled (35°), with rounded edge. Thickened suboral cone not over 0.25 o.d. in height, with outward contour forming a segment of an inverted cone of 35–40°. Bowl and horn, respectively, 0.53–0.60 (0.56) and 0.47–0.40 (0.44) t.l. Bowl short, rotund conical (15–20° as a whole), 2.3–2.7 (2.5) o.d. in length, not clearly divisible into an upper and lower cone because of gradually rounded shoulder at transition. Upper cone 0.58–0.70 length of bowl, convex subconical, 5° increasing to 10°; lower cone more nearly conical, 25–40°, blending gradually into horn. Aboral horn 1.6–2.5 (1.9) o.d. in length, and with upper diameter 0.10–0.17 (0.14) its length, a tapering cone decreasing quickly from a concave cone of 15° above to 5° or less in most of its course, and with terminal 0.3 o.d. its length again tapering (15°) more rapidly. Tip truncate and minutely open. Section immediately above terminal taper always *optically differentiated* with thicker walls of a deeper tint and larger, thicker-walled prisms. This region corresponds to the knob of Rhabdonellopsis. Wall thin, very hyaline, and with very light canary-yellow tinge; thickest in shelf, decreasing abruptly below for greater part of bowl and horn, thickening again in "knob"; trilaminate, with thin lamellæ, enclosing a single layer of distinct prisms, increasing to 2–4, rarely 7–8, in shelf, 4–6 between ribs, and 75–80 across one face, largest above, maintaining uniformity in size to very rim, and decreasing but little posteriorly, with an incomplete row of larger prisms along base of each rib. Ribs 30–42 (34), nearly vertical on bowl, unusually straight, equidistant, except near bifurcations, rarely with any terminal sinistral curvature on shelf, but with a slight (5–8°) *dextral* spiral on horn, especially in lower 0.5. In one deformed lorica with a

stumpy Cyttarocylis-like horn (Plate 13, fig. 8) the spiral region is crowded and more oblique (45°). Spiral course made out with difficulty, best seen on *lower* surface, hence the ease of reversal in drawing. Ribs bifurcate very freely, as might be expected with widely conical bowl, usually to left, ranging whole length of bowl, but more abundant in lower 0.5, with few suboral bifurcations. Anastomoses, interpolations, and fusions are rare. Fenestræ faint, thin-walled, flaring but little internally, broadly elliptical in outline, submedian in intercostal space, beginning 0.25 o.d. below rim, extending in reduced number, smaller size, and relatively shorter transdiameter on horn, 12–16 in each full-length intercostal space on bowl. Thin wall of bowl not deeply impressed around each fenestra as in *quantula*. Body attached near fundus of bowl and nearly filling it, with 2 large, broadly ellipsoidal macronuclei 12 by 16μ, and adjacent spheroidal micronuclei 6μ in diameter.

Ten loricæ: L., total, 205–262 (224.4); bowl, 123–138 (126.5); horn, 80–125 (97.8). D., oral, 47–53 (51.0); lip, 55–64 (60.9); midway, 19–29 (24.4)μ.

At 6 stations, viz., at 5 and 1, respectively, in California and Peruvian currents; at 69–83 (72.7)°; 141 loricæ.

Rhabdonella henseni (Brandt) Brandt.

Plate 13, fig. 1

Lorica tall chalice-shaped, with flaring bowl and very long, stout horn; 3.69–5.75 o.d. Brandt's loricæ (3.67–3.79 o.d.) are probably flattened. Oral rim very low, not over 0.03 o.d. in height, thin, everted, short segment of inverted cone of 30°. Oral diameter 0.16 (in Brandt's loricæ 0.26–0.27) t.l. Circumoral shelf very narrow, not over 0.04 o.d. Circumoral gutter narrow, shallow, sloping inward to an angle against rim. Lip abruptly rounded, almost semicircular in section. Suboral thickening only 0.13 o.d. in height, not sloping inward. Bowl subcylindrical (subconical [10°] in Brandt's lorica) in upper 0.65–0.70, subconical (35–40°) in lower 0.4–0.3, changing rather abruptly from upper to lower cone, its length 0.56–0.64 t.l. or 2.23–3.19 o.d. Horn 0.36–0.44 t.l., or 1.37–2.52 o.d., subcylindrical or narrowly conical above, tapering in distal 0.25 to a blunt aboral end, closed in Brandt's lorica, but open in ours, its diameter near middle 0.10–0.12 o.d. Wall thin, thickest in suboral ridge, thinning below, and thinnest in lower bowl, but thickening to thrice this in horn; trilaminate, with thin lamellæ enclosing 1–3 layers of minute, fairly regular prisms, 100–110 across one face of bowl, somewhat larger in the lower horn. Ribs 36–48, in-

creasing to 42, 48, or more, below suboral ridge, somewhat interrupted in Brandt's loricæ, but not in ours, and somewhat irregular, but not spiral, in their subvertical course on upper bowl and horn, anastomosing rather freely, not only by divarication but also by fusion, and not maintaining equidistant positions continuously; thin, hyaline, prismatic, extending radially for a distance equal to thickness of wall, and decreasing aborally to low ridges on horn, heavier and more distinct in this species than in most species of Rhabdonella. Fenestræ circular to broadly elliptical, located in middle of intercostal space, with their long axes vertical, a few only found below lower cone, 13–19 in one intercostal space, not exceeding 0.05 o.d. in length of major axis.

L., total, 354; bowl, 198; horn, 156. D., oral, 62; lip, 68; shoulder, 60; horn, 6μ.

At Sta. 4675 in Peruvian Current; at 68°; 1 lorica.

Rhabdonella indica Laackmann

Plate 12, fig. 15

Lorica tall goblet-shaped, convex subconical; 1.86–2.16 (1.94) o.d.; consisting of bowl with abruptly spreading suboral lip and high oral rim. Suboral lip flaring 30° from vertical for 0.16 o.d. to its edge of 1.09–1.23 (1.15) o.d. Oral rim 0.1 o.d. in height, truncated segment of cone (30°). Oral diameter 0.46–0.64 (0.50) t.l. Edge of suboral lip rounded, entire, upper surface sloping obliquely downward and inward, in a gutter obliquely semicircular in section. Bowl vaguely divisible into upper and lower parts, forming, respectively, 0.55–0.60 and 0.45–0.40 its length, with upper and lower truncated segments of inverted convex cones of 12–20° and 50–60°, respectively. Aboral end acute, closed, sometimes with minute tip. Wall uniform in thickness, except in suboral region, composed of a homogeneous, greenish yellow, hyaline substance, distinctly trilaminate only in suboral shelf; elsewhere two lamellæ fused. Delicate, thin-walled, very faint prisms demonstrable only in thickened suboral region in 1–3 layers, 3 across one intercostal space, and 110–120 across one face. Ribs very faint, low, scarcely interrupting marginal contour, 36–42 (38), running from rim to aboral end, bifurcating rarely on upper bowl, deflected spirally 15° to left. No fenestræ.

Five loricæ: L., total, 56–63 (59.6). D., oral, 26–34 (30.7); oral lip, 32–39 (35.2)μ.

At 15 stations, viz., at 1, 1, and 13, respectively, in Peruvian Current, Galapagos Eddy, and Drift; at 71–81 (75.9)°; 32 loricæ.

Rhabdonella inflata Kofoid and Campbell

Plate 14, figs. 4, 5

Lorica long-bowled, stout, convex conical chalice-shaped; 3.0–4.1 (3.5) o.d. Oral rim cylindrical, prominently protuberant, exceeding shelf by 0.5 its height which is 0.5 width of shelf, but in some loricæ lip is more elevated, gutter deeper, and shelf and rim equal in height. Oral margin rounded, a direct fold of inner lamella. Oral diameter 0.27–0.33 (0.30) t.l. Suboral lip 0.06–0.10 o.d. in width, diameter at its edge 1.11–1.20 (1.17) o.d. Circumoral gutter shallow concave, or deeper, sloping inwardly in loricæ with higher lip, with rounded rim, and lower surface flaring 20–40° from bowl and merging abruptly with it. Bowl and horn, respectively, 0.65–0.72 (0.69) and 0.35–0.28 (0.31) t.l. Bowl 2.0–2.9 (2.4) o.d. in length, with convex contour and full lower bowl; with upper subcylindrical (1–7°) section forming 0.5 length of bowl and a lower convex conical (30–45°) contour. Transition to horn abrupt. Aboral horn concave inverted segment of cone, 15–25° above, decreasing to 5° or even to cylinder below, but increasing again towards distal end to 10° for 0.25 o.d., upper diameter 0.16–0.25 its length. Tip truncate, with minute opening. Wall relatively thick, thinning gradually aborally from shelf in bowl, increasing in upper horn and decreasing in lower; trilaminate, with very thin lamellæ enclosing 1 layer of prisms, increasing to 2–4 in shelf. Prisms faint, thin-walled, regular, uniform, 5–10 between ribs and 175 across one face, largest suborally and in lower horn. Ribs 42–60 (53), distinct, subvertical, sometimes with a slight sinistral spiral not over 5° on bowl, with traces of a right spiral on lowermost bowl and horn, and always with a suboral sinistral curve of 10–30°, sometimes even 70°, pervading all ribs, or groups, or even single ribs, with a pervading irregularity of direction and course which interrupts the equidistant relationship of ribs, manifested in approximations, interpolations, coalescences, local distortions, imperfections, and bifurcations at all levels, especially in suboral zone, where they are often feebly developed, on lower bowl, and occasionally on midbowl, extending to lower end of horn in crowded array and reduced number. Fenestræ 18–26 in number in one intercostal space on bowl, continued on horn in reduced numbers, laterally compressed, beginning at 0.1–0.3 o.d. below rim, extending to aboral tip, irregularly submedian, small, thin-walled, less distinct than in *R. hebe*, irregularly subcircular, with little inward flare in optical section, sometimes double or paired, 0.25–0.30 an intercostal space in diameter, and wall not externally impressed around them.

Body filling 0.75 of diameter of bowl, and extending from its fundus nearly to rim.

Ten loricæ: L., total, 124–204 (167.9); bowl, 80–144 (116.2); horn, 37–68 (51.7). D., oral, 40–55 (47.8); lip, 47–66 (55.9); midway, 25–39 (33.2) μ.

Loricæ are shorter (124–200 [154]μ) in the warmer northern waters at 71–84 (78.3)° than in the southern (134–204 [177]μ) at 66–75 (69.3)°. Of the northern loricæ those at Sta. 4571 (71°) are most like those of the South. At stations along the Central American coast (4607–4615) loricæ are not only smaller but are more tapering below, viz., 30–37°, as compared with 35–55° in southern waters. These structural differences appear to be correlated with differences in temperature operating on size and proportions of the species within its range. At warmer stations the loricæ are smaller and have less material in them than at colder ones.

At 23 stations, viz., at 1, 3, 14, 4, and 1, respectively, in California, Mexican and Peruvian currents, Panamic Area, and Drift; at 66–84 (72.1)°; 197 loricæ.

Rhabdonella lohmanni Kofoid and Campbell

Plate 14, figs. 6, 9

Lorica tall, very stout, vase-shaped, with little oral flare, long bowl and stout horn; 4.57–5.76 (5.43) o.d. Oral rim minute, 0.02 o.d. in height, triangular in section, with oblique inner and outer slopes with rounded upper angle (10°), completely exposed above shelf. Oral diameter 0.18–0.22 (0.19) t.l. Circumoral shelf faintly developed, hidden in expanded fin-like ribs, which creep up on to its very top and are suddenly widened below it so as to fill out the subcylindrical contour completely, 0.036–0.08 (0.06) o.d. in width, and diameter to outer margin of lip 1.07–1.15 (1.12) o.d. Circumoral gutter reduced to a slight inward inclination of the almost flat shelf. Lip not protruding, angled (80°), with rounded edge. Suboral thickening diminishing gradually from angle for 0.2 o.d., its contour included within a short segment of an inverted concave cone of 20°. Bowl cylindrical, or slightly tapering (5°), in its upper 0.7, the lower cone (30–35°) 0.3 length of bowl; transition from upper to lower cone and from this to horn somewhat gradual, though occasionally abrupt as in *henseni*. Aboral horn stout, 1.71–2.06 (1.87) o.d. and 0.33–0.38 (0.35) t.l., with diameter near middle 0.13–0.19 (0.16) o.d., subconical (10°), often slightly asymmetrical, tapering unevenly throughout, but more

rapidly (20°) in distal 0.25, with a slight enlargement in central canal at about level of "knob" region. Tip blunt, closed. Wall thin below suboral lip, thinning gradually in lower bowl, thickening again in horn; trilaminate, with thin lamellæ enclosing 1–3 layers of fine prisms of fairly uniform size, 150–200 across one face, increasing in size in lower end of horn with 8 across one face in thick, yellowish wall, elsewhere hyaline, with only a slight tint. Ribs 30–48 (39) across one face on upper bowl, increasing to 54 immediately below suboral lip, and decreasing to 12–15 at top of horn, running an obliquely longitudinal course, turning to the *right* 15–25° on lower part of cylindrical section of bowl, and gradually decreasing in slope orally to vertical in upper 0.2 of bowl, deflection continuing in a few loricæ up to suboral ridge, tending to branch near upper end, and to turn sharply to *left* immediately below top of bowl, the right spiral course of ribs in this species reaching extreme degree of divergence from the left spiral course in *spiralis* and other species, the short turn to the left in the suboral region being the only trace of the direction generally dominant elsewhere in the genus. Ribs not equidistant, frequently branching and anastomosing, with secondary anastomoses of faint, more oblique riblets connecting adjacent ribs, not much elevated except just below lip, being merely low structural folds of the surface lamellæ, hyaline, prismatic, in places ragged or nodular, and locally sinuous, especially near upper ends. Fenestræ very small, about half the size of those of *henseni*, circular, appearing on high focus to be encircled by an opaque, whitish zone, and on deeper focus to enlarge to a zoneless circle, due to the fact that they have the form of a truncate cone with outer diameter 0.5 of inner. Fenestræ 6–12 in full length of an intercostal space, usually near its midline, mainly on bowl, but with a few straying down upon horn, varying in size, not exceeding 0.04 o.d. and usually much smaller.

Ten loricæ: L., total 317–377 (341.4); bowl, 200–250 (223.6); horn, 110–130 (117.8). D., oral, 58–68 (62.9); lip, 64–77 (70.3); shoulder, 52–63 (57.8); horn, 8–12 (10.0) μ.

At 4 stations, viz., at 1 and 3, respectively, in Peruvian Current and adjacent Drift; at 68–69 (68.2)°; 10 loricæ.

Rhabdonella poculum (Ostenfeld and Schmidt) Brandt

Plate 12, fig. 11

Lorica very short, very stout goblet-shaped, with a relatively wide bowl and short horn; 1.83–2.11 (1.97) o.d. Less abruptly divided into

bowl and horn in our material than in Ostenfeld and Schmidt's figure (1901, fig. 27). Oral rim no higher than lip, an outwardly inclined extension of thickened inner lamella, forming truncated segment of cone of 30°. Oral diameter 0.51–0.62 (0.61) t.l. Circumoral shelf 0.10–0.12 o.d. in width, its diameter to margin of broadly rounded lip 1.10–1.27 (1.21) o.d. Suboral thickening flaring outwardly in an inverted cone of 22°, extending posteriorly for 0.15 o.d. Bowl 1.61–1.75 (1.64) o.d. in length, forming 0.77–0.90 (0.82) t.l., contracting near its distal 0.25 in abrupt shoulder delimiting upper and lower sections. Relative lengths of upper and lower bowls, respectively, 0.60–0.65 and 0.40–0.35 length of bowl, with angles of cone 10–15° and 70–75°. In Ostenfeld and Schmidt's figure (1901) the lower cone is 120°. Transition from lower bowl to horn very gradual. Aboral horn concave conical (30–40°). Tip acute or blunt, closed, length 0.10–0.23 (0.18) t.l., or 0.17–0.39 (0.29) o.d. Wall uniform in thickness throughout most of bowl, increasing to 0.10 in suboral rim, composed of heavy inner and outer lamellæ enclosing 1–2 layers of fine, regular, nearly uniform prisms, 4–5 across an intercostal space in upper bowl, and 90–110 across one face, with 3 layers in rim and larger and thicker-walled in horn, with yellowish tint, less clearly hyaline than in most species of the *amor* group. Ribs 42–54 (45.4), slightly spiral, passing orally to left, more abruptly on lower cone (30°), and immediately below rim (45°), on whose edge they fade out, producing a slight undulation, bifurcating occasionally on lower bowl and below rim, sometimes anastomosing, quite regular in their course, and uniformly spaced. Fenestræ, not noted by Ostenfeld and Schmidt, very small, and very faint by reason of thinness of their walls, very numerous, 40–50 in an intercostal space, not in a linear arrangement but scattered irregularly from below suboral rim almost to lower end of horn. Body attached by a slender stalk running to bottom of horn.

Ten loricæ: L., total, 73–80 (75.8); bowl, 59–70 (62.5); horn, 8–17 (13.3). D., oral, 37–40 (38); lip, 44–49 (46.1) μ.

At 24 stations, viz., at 2, 6, 3, 8, 2, and 3, respectively, in California, Mexican, and Peruvian currents, Panamic Area, Galapagos Eddy, and Drift; at 69–84 (77.2)°; 178 loricæ.

Rhabdonella quantula Kofoid and Campbell

Plate 13, figs. 2, 3

Lorica short, tapering, narrow chalice-shaped; 3.4–4.2 (3.7) o.d. Oral rim slightly emergent, projecting not over 0.03 o.d., an erect, low

cylinder formed by projection of inner lamella. Circumoral gutter very shallow. Suboral shelf 0.10–0.12 o.d. in width, with diameter to its edge 1.19–1.25 (1.21) o.d. Lip with rounded angle, scarcely projecting, with rim showing undulations due to overlap of ribs, with outer surface merging so gradually with slope of bowl as to show little flare. Bowl and horn, respectively, 0.56–0.65 (0.60) and 0.44–0.35 (0.40) t.l. Bowl rotund conical, with transition from upper to lower cone lost in convexity. Upper section 0.4–0.6 of length of bowl, an inverted segment of cone (5–13°), increasing to 35–50° in lower cone. Transition from bowl to horn gradual and not always symmetrical. Aboral horn 1.3–1.8 (1.5) o.d. in length, very slender, forming a concave, tapering, inverted cone decreasing from 25° above to 5°, or even to a cylindrical form distally, its upper diameter 0.12–0.16 its length, and lower 0.05 or less. Aboral tip truncate, minutely open, or closed. Wall thinning below shelf, decreasing gradually on lower bowl, and in lower horn, almost occluding lumen, trilaminate with unusually heavy lamellæ enclosing a single layer of distinct, regular, uniform prisms, increasing to 2–3 in shelf, 3–8 (5) across one intercostal space and 120 across one face, becoming very indistinct in horn, where the two thick lamellæ are almost fused, obliterating the prismatic structure, hyaline, dense, with a trace of yellowish tint. Ribs 36–54 (44), subvertical, or sinistral in direction up to 15° and, in some ribs and loricæ as a whole, showing a suboral sinistral deflection up to 20°, equidistant and regular in their course, with few bifurcations in suboral zone and more on lowermost part of lower cone, with frequent anastomoses to left, numerous interpolations, and occasional approximations and fusions. Fenestræ distinct, circular above, becoming elliptical on horn, flaring inwardly, with inner diameter not over 0.2 intercostal space, submedian in single row and 5–12 in each space on bowl, and in smaller numbers and obscure on horn, beginning 0.3–0.4 o.d. below rim and subequally distributed among intercostal spaces. Body attached laterally near bottom of bowl, filling about 0.4 of lumen, with 20 membranelles, 2 macronuclei of broadly ellipsoidal form, 10 by 15μ, each with spheroidal micronucleus 5μ in diameter adjacent to it.

Ten loricæ: L., total, 138–172 (151.6); bowl, 83–104 (91.4); horn, 51–68 (60.2). D., oral, 37–44 (40.6); lip, 46–53 (49.1); midway, 17–25 (21.8)μ.

At 38 stations, viz., at 3, 13, 3, 2, 1, 13, 1, and 2, respectively, in California, Mexican, South Equatorial, Equatorial Counter, and North Equatorial currents, Panamic Area, Galapagos Eddy, and Drift; at 69–85 (79.6)°; 781 loricæ.

Rhabdonella spiralis (Fol) Brandt emended Kofoid and Campbell

Plate 15, fig. 6

Non *Rhabdonella elegans* Jörgensen, 1924, fig. 67 (see *R. elegans*).

R. striata, partim, K. and C., 1929, p. 219 (all of Brandt's *Ptychocylis* [*Rhabdonella*] *spiralis* var. *c. indopacifica*, including his pl. 52, fig. 1, goes to *R. spiralis*).

Lorica tall, conical to subcylindrical chalice-shaped, with subequal bowl and horn; 5.1–6.1 (5.6) o.d. Oral rim not over 0.015 o.d. in height, not equaling height of lip or projecting but slightly above it. Oral margin thickened, rounded. Oral diameter 0.15–0.20 t.l. Circumoral shelf 0.1 o.d. in width, diameter to margin of lip 1.2 o.d. Circumoral gutter very shallow, slightly concave, sloping gently to base of oral rim. Lip bluntly angled (70–80°), protruding but little. Suboral thickening slight, gradually fading out within 0.25–0.30 o.d. below lip, forming an inverted cone of 15–30°. Bowl and horn quite well differentiated, respectively, 0.50–0.61 (0.55) and 0.50–0.39 (0.45) t.l. Bowl readily divisible into upper and lower cones; upper 0.60–0.65 length of bowl, with angle of 8–10°, with almost straight sides, except in suboral region; lower 0.35–0.40 length of bowl, with more convex contour, and wider angle (26–30°). Transition into horn gradual. Aboral horn elongate conical, 9–10°, measured from tip to top, with angle increasing from 3–4° in lower 0.6–0.8 to 15° in upper part, 2.0–2.9 (2.5) o.d. in length, and upper diameter 0.1–0.2 its length. Aboral tip truncate, open, and pierced by slender central canal. Brandt (1907) and Laackmann (1909) find the tip closed. Wall thin, hyaline, colorless to tinged with yellowish olive color; thickest in shelf, thinning on lower bowl, and in horn, thickening slightly again at tip; trilaminate, with heavy lamellæ enclosing a single layer of subregular, subuniform, faint prisms, increasing to 2–3 in shelf, diminishing in size aborally, 6 between ribs and 100 across one face on upper bowl. Ribs 36–60 (47.2), distinct, especially on bowl, extending from crenulated edge of shelf, running well down on horn where they are difficult to follow, often bifurcating on suboral flare with few anastomoses and coalescences on lower bowl, nearly equidistant, but crowded together on upper horn, subvertical in upper bowl but forming an ascending left spiral not exceeding 18° on lower, with considerable range of obliquity in different loricæ, little if any sinistral curvature at shelf, as in many forms of *amor*. Fenestræ distinct, thick-walled, 10–14 in an intercostal space on bowl, extending from below suboral thickening to upper horn, circular

to elliptical in outline, varying from 0.2 to 0.4 of an intercostal space in diameter even at same level, irregularly distributed, and smaller on horn, with wall depressed about each. Animal filling the bowl fully in its lower cone, with 20 membranelles, and 2 ellipsoidal macronuclei 9 by 14 μ.

Ten loricæ: L., total, 272–365 (308.3); bowl, 150–211 (170.7); horn, 117–166 (137.6). D., oral, 50–60 (55.4); lip, 58–68 (64.1); midway, 14–38 (25.3) μ. In the first of Fol's papers the length is given as 400 μ, while later (1884) it is said to be 312 μ.

The average length of 3 loricæ from 67–75° is 333 μ, while 7 from 76–83° average 298 μ.

At 34 stations, viz., at 3, 6, 8, 3, 6, and 8, respectively, in California, Mexican, Peruvian, and South Equatorial currents, Panamic Area, and Drift; at 66–84 (76.7)°; 210 loricæ.

Rhabdonella striata (Biedermann) Brandt emended Kofoid and Campbell

Plate 13, fig. 10

R. striata, partim, K. and C., 1929, p. 219, fig. 411 (for *Ptychocylis spiralis* var. *c indopacifica* Brandt, *partim*, 1906, p. 26, pl. 52, fig. 1, see *R. spiralis*).

Lorica moderately short conical chalice-shaped, with tapering bowl and very long horn; 3.3–4.6 (4.1) o.d. Oral rim erect or flaring 10°, very slightly if at all emergent, not over 0.025 o.d. in height. Oral margin thickened with rounded edge. Oral diameter 0.22–0.30 (0.24) t.l. Circumoral gutter wide, shallow, concave, 0.10–0.14 o.d. in width, and 1.15–1.27 (1.19) o.d. to outer margin of lip. Lip slightly undulating, angular (50°), with a rounded margin, only slightly protuberant, its outer contour within an inverted cone of 35–40°. Suboral thickening feebly delimited, not over 0.14 o.d. in height. Bowl and horn, respectively, 0.56–0.66 (0.61) and 0.44–0.54 (0.49) t.l. Bowl 2.2–2.8 (2.5) o.d. in length, not readily divisible into upper and lower sections because of gradual slope or widely extended convexity of sides. Shoulder, when present, located from 0.4 to 0.7 length of bowl from rim. Angle of upper cone 10°, increasing to 25–35° in lower. Lateral outline convex throughout, but greater in lower cone. Aboral horn 1.2–2.0 (1.6) o.d. in length, with upper diameter 0.16–0.25 length, a concave, tapering cone decreasing from 15° above to 5°, or almost a cylinder, below, with distal increase for (0.1 o.d.) to 10–15°. Tip truncate, open. Wall thick, decreasing below shelf in upper and lower bowl, thickening in lower horn; trilaminate, with very heavy lamellæ which are themselves faintly prismatic with thick-walled

prisms, enclosing one layer of subregular, subuniform, distinct prisms increasing to 2–3 in shelf, largest in shelf, 5–12 (8) between ribs and 125 across one face, decreasing aborally in size and increasing again in lower horn in a fashion suggestive of knob of *hebe*. In lower horn inner lamella very thin. Ribs 24–54 (35), vertical or at most with not over 5° sinistral torsion on bowl, sometimes individually or around whole lorica with abrupt, sinistral curve of 45° on lower slope of shelf, bifurcating freely on suboral region and lowermost bowl to right or left. Many loricæ with a characteristic wavering in direction, not sinuous or regular, which locally disturbs the relations of equidistance so characteristic of ribs of *conica* and *hebe*. Frequent confluence, anastomosis, and approximation. Fenestræ remarkably distinct, irregularly subcircular in outline, flaring internally, 0.25–0.40 of an intercostal space in diameter, 4–9 (6) between ribs on bowl, submedian, beginning rather near (0.2 o.d.) rim, and extending to tip of horn in reduced size. Body smaller in proportion to bowl, than in other short species, with 2 ellipsoidal macronuclei 12 by 16 μ, and 20 membranelles.

Ten loricæ: L., total, 171–239 (200.5); bowl, 107–135 (122.7); horn, 63–104 (77.8). D., oral, 43–53 (48.9); lip, 53–64 (58.3); midway, 23–31 (25.9) μ.

Described by Biedermann (1893) as *Tintinnus striatus* and later referred by Brandt (1906) to Ptychocylis, and still later (1907) waveringly by him to Rhabdonella, and then reduced to a mere form of *R. spiralis*. It is not to be confused with *Bursaopsis striata* quoted by Entz, Jr. (1909b) as *Tintinnus striatus*, nor with the *Cyttarocylis striata* of Cleve (1901a), which we (1929) renamed *Protorhabdonella striatura*.

It is evident on comparison of Brandt's figures (1906) with Biedermann's (1893) rather generalized original figure that there is much uncertainty as to the specific identity of the two. However, since Biedermann's material was in Brandt's hands, and his investigation under Brandt's direction, we accept Brandt's description and figures as emendatory to those of his pupil. The greatest differences lie in the configuration of the suboral shelf as shown in Biedermann's (1893) detailed figure (13b). This is more flaring than in typical *R. striata* as we find it, and as Brandt incompletely figures it. However, his first figure (13a) is so generalized that it might as well be placed in *R. striata* as anywhere.

At 23 stations, viz., at 4, 3, 5, 6, and 5, respectively, in California, Mexican and Peruvian currents, Panamic Area, and Drift; at 67–85 (75.5)°; 190 loricæ.

Rhabdonella torta Kofoid and Campbell

Plate 13, figs. 4–6

Lorica long-bowled, tapering chalice-shaped, or stout gimlet-shaped; 3.98–4.22 (4.10) o.d. Suboral flare very slight, due to gradual merging of suboral shelf with bowl and its slight thickening. Oral rim scarcely emergent, thickened somewhat, slightly everted. Oral diameter 0.25 t.l. Circumoral gutter angled, shallow, with inward slope of shelf. Lip with bluntly rounded projecting angle, with undulating edge due to overlapping ribs. Shelf 0.08 o.d. in width, and diameter to margin of lip 1.17 o.d. Suboral thickening flaring in a segment of an inverted cone (25°). Bowl not distinctly pedicellate, as in *valdestriata*, concavity in lower part so slight as to make separation of bowl and horn arbitrary, abrupt change in torsion of ribs indicating transition here, as in *poculum*. Bowl 2.87–3.15 o.d. in length, roughly divisible into an upper section 2.0 o.d. in length, inverted segment of cone of 5–6°, and lower, 1.0 o.d. in length with angle of 28–34°. Transition from lower cone to horn gradual, with decrease from 28–34° to 15–20°. Lateral outlines of lower bowl and horn together slightly concave. Aboral horn 1.07–1.15 o.d. in length, upper diameter 0.35–0.40 length, forming a slightly concave inverted cone of 15–20°. Tip minutely truncate and obscurely open. Wall heavy, dense, with an olive-yellow tint; fairly uniform in thickness throughout, thickening in suboral shelf, and locally thickened in the horn; trilaminate, with heavy lamellæ, depressed around fenestræ, giving an undulating, irregular appearance to its optical section, including a single layer of prisms, increasing to 3 in suboral region, 2–6 across an intercostal space, and 100–115 across one face. Ribs very evident, rather heavy, somewhat crowded, equidistant as a whole, but subject to many minor irregularities, such as sinuosities, approximation, bifurcation and reunion, coalescence, interpolation, and numerous feeble anastomoses in either direction; their course unique and characteristic, extending from aboral end, where their number is much reduced, to upper surface of suboral shelf, pursuing a right spiral course instead of the customary one to left, except immediately below shelf, where they turn left 30–35°. The right spiral starts in lower horn at 5°, increases at its upper end to 35°, and continues at 5° on most of bowl. In this matter of direction of ribs it resembles *lohmanni*. Ribs 54–60, counting uppermost bifurcations. Fenestræ large, circular, 2–3 μ in diameter, with thick walls, 4–8 in each intercostal space near its middle, not on thick-walled suboral region, but continuing in reduced size well down on aboral horn.

Two loricæ: L., total, 210–228; bowl, 150–170; horn, 58–60. D., oral, 53–54; lip, 62–64 μ.

At 2 stations, viz., at 1 each in California Current and Drift; at 75–83°; 2 loricæ.

Rhabdonella valdestriata Brandt

Plate 13, fig. 13

Lorica slender conical, or tall tapering chalice-shaped; 4.02–4.89 (4.47) o.d. Oral rim very low, 0.03 o.d. in height, erect, scarcely higher than suboral shelf. Oral diameter 0.20–0.25 (0.22) t.l. Circumoral shelf very narrow, not over 0.1 o.d. in width, diameter to outer margin of lip 1.13 o.d. Circumoral gutter scarcely deepened below level of shelf. Lip slightly flaring, rim angled and edge rounded. Suboral thickening with a height of 0.25 o.d., its outer contour included within a cone of 35°. Bowl and horn, respectively, 0.65–0.73 (0.68) and 0.35–0.27 (0.32) t.l. Bowl 2.60–3.23 (3.03) o.d. in length, divisible into an upper subconical section, 0.60–0.65 length of bowl and angle 8–12°, with almost straight sides, and a lower, more convex conical section, 0.40–0.45 length of bowl, with angle of 27–30°. Transition between two cones gradual, but less so than that of lower cone to horn. Aboral horn tapering cone 1.20–1.66 (1.44) o.d. in length, with an angle of 8–10°, and upper diameter 0.18–0.23 its length. Tip blunt, closed. Wall dense and thick, with faint yellowish-brown tinge, subuniform in thickness, increasing in suboral shelf, and not increasing locally in horn, irregular in optical section because of depressions about fenestræ, trilaminate, with heavy, prismatic (*fide* Brandt, 1907) lamellæ enclosing 2 layers of uniform, regular prisms, increasing to 3–4 in suboral region. Prisms somewhat larger in suboral region and horn, with single layer in latter, 5–12 in intercostal space and 200–250 across one face. Ribs 36–54 (45), very low, stout, well defined, somewhat sinuous with minor irregularities, subequally spaced, bifurcating on lower cone and in uppermost part of bowl, branching to either side, and in a few cases anastomosing to right, with rare interpolations. Their course subvertical with little sinistral deflection in suboral region, extending from lower horn to undulating edge of shelf. Fenestræ large, well defined, and relatively few, 7–10 (5–16) in one intercostal space, decreasing in number and size on horn, and not invading suboral zone, circular or broadly elliptical, with long axis vertical, 0.25–0.50 of an intercostal space in diameter, with heavy walls. Body large, almost filling bowl, with 2 ellipsoidal macronuclei, 10 by 16 μ, and 2 small adjacent micronuclei.

Seven loricæ: L., total, 213–238 (228.1); bowl, 138–166 (154.6); horn, 60–80 (73.6). D., oral, 47–56 (51.1); lip, 55–64 (59.6) μ.

At 5 stations, viz., at 3, 1, and 1, respectively, in California Current, Easter Island Eddy, and Drift; at 69–83 (75)°; 15 loricæ.

23. RHABDONELLOPSIS Kofoid and Campbell

Rhabdonellidæ with elongated, chalice-shaped lorica with long, slender pedicel, small knob, and lance; circumoral shelf flattened, gutter with longer outer slope and steeper inner one between inner and outer lamellæ; bowl inverted subconical with long upper and very short lower cone; aboral horn 2–4 o.d. in length, made up of very long pedicel, knob, and lance; wall with 10–20 vertical, simple, or branched, or, sometimes, anastomosed ribs; fenestræ few to many or rarely none in each intercostal space; lamellæ well developed, with primary structure and a coarser secondary prismatic layer in intermediate region; marine, eupelagic in temperate and tropical seas. Type species *Rhabdonellopsis apophysata* (Cleve) K. and C. from Atlantic, widely distributed, and the oldest species in genus.

Established by Kofoid and Campbell (1929), who assigned to it 6 species hitherto belonging to Cyttarocylis and Rhabdonella. The oldest species is Cleve's (1901d) *Cyttarocylis hebe* var. *apophysata*, which Brandt called *Ptychocylis* (*Rhabdonella*) *apophysata* var. *b*, and which Jörgensen included with our *Rhabdonellopsis triton*, *Rdps. composita*, and *Rdps. minima* as one species. We included, also, Brandt's *Ptychocylis* (*Rhabdonella*) *apophysata* var. *a composita* as *Rdps. composita;* and also, as *Rdps. minima*, Ostenfeld and Schmidt's (1901) *Cyttarocylis hebe* which Brandt called *Ptychocylis* (*Rhabdonella*) *spiralis* var. *a hebe* in part, and which Jörgensen (1924) included in his *Rhabdonella apophysata*. We also included *Cyttarocylis triton* Zacharias (1906) as *Rdps. triton* (Zach.), a species which Brandt (1906) included in his *Ptychocylis* (*Rhabdonella*) *apophysata*, Laackmann (1913) in his *Rhabdonella spiralis*, and Jörgensen (1924) in his *R. apophysata*. To these species we added two new ones, *Rdps. intermedia* and *Rdps. longicaulis*, from Expedition material.

Includes 7 species of which 5 are present in Expedition material. Of these 7 species 3 were described as new (K. and C., 1929) from Expedition material, and one, *Rdps. constricta* spec. nov., is added in this report.

Rhabdonellopsis constricta spec. nov.

Plate 15, fig. 2

Rdps. minima, partim, K. and C., 1929, p. 222, fig. 423 (non p. 224; see *Rdps. minima*).

Lorica very tall chalice-shaped, with very short conical bowl, long pedicel, high lip, and unique suboral constriction; 4.5 o.d. Bowl, pedicel, and lance, respectively, 0.51, 0.34, and 0.15 t.l. Oral rim lower than lip, inner lamella not protruding above acute angle forming inner side of gutter. Oral diameter 0.22 t.l. Circumoral shelf narrow, with width and diameter to margin of lip, respectively, 0.05 and 1.10 o.d. Gutter unique, a narrow concave channel less than 0.5 width of shelf, crowded against oral rim. Lip unusual, rising twice depth of gutter above level of oral rim, an angular (60°) lobe in section with broadly rounded, somewhat irregularly sinuous edge and almost vertical outer face. Suboral thickening 0.25 o.d. in height, decreasing abruptly within half this distance below rim, tapering gradually through and somewhat below suboral constriction into normal wall. Suboral contour contained within an inverted cone of 22°, bowl flaring below suboral constriction for 0.19 o.d. in a cone of 10°. Diameter in constriction 1.05 o.d. Bowl distinctly conical, much wider than in other species, at shoulder an inverted cone of 16°, changing gradually to 30° and then to 15°, with resulting lateral concavity, 0.51 t.l. measured to level of 2.35 o.d. below rim where slope changes; maximum diameter (1.1 o.d.) at shoulder below suboral constriction. Transition to horn gradual. Pedicel to upper limit of knob 1.1 o.d. in length, an inverted cone of 4°. Knob 0.36 o.d. in length, unequally fusiform in shape, its upper and lower segments asymmetrical cones of 30°, with a diameter 0.12 o.d. Lance 0.5 o.d. in length, an inverted, asymmetrical cone of 5°, with open truncated tip, and slight flare in central canal. Wall relatively thin, increasing in shelf and knob, trilaminate, with thin equal inner and outer lamellæ enclosing a single layer of regular prisms, 110 across widest part of bowl and 12–15 in an intercostal space, increasing in number from 2 to 6 in suboral thickening, but decreasing in size progressively towards rim, larger in knob, 9 across one face. Ribs 22, leiotropic (20°) in upper bowl, without suboral increase or obliquity, increasing to 30° on lower bowl, becoming subvertical on pedicel, widening into fins in suboral constriction, very faint, with few bifurcations on upper bowl. Fenestræ sparsely distributed, mainly on bowl and knob, with few on pedicel, subcircular in shape, uneven in diameter, 10 in one intercostal space, median in location in intercostal zone. A

cluster of 3 in wall of knob with double contour resembling that of minute coccoliths.

L., total, 270; bowl, 138; pedicel, 76; knob, 20; lance, 36. D., oral, 52; lip, 58; knob, 8μ.

At Sta. 4712 and 4731 in Drift; at 74–79.5 (76.7)°; 3 loricæ.

Rhabdonellopsis intermedia Kofoid and Campbell

Plate 16, fig.1; Plate 17, figs. 5, 6, 8, 10

Lorica relatively short chalice-shaped, with bowl about equaling horn; 4.72–6.08 (5.34) o.d. Bowl, pedicel, and lance, respectively, 0.47–0.55 (0.51), 0.47–0.33 (0.41), and 0.04–0.12 (0.08) t.l. Oral rim thin, projecting above outer lip 0.04 o.d. and flaring 10–15° outwardly. Oral diameter 0.16–0.21 (0.19) t.l. Circumoral shelf slightly concave above, deepest near oral rim, its width and diameter to margin of lip, respectively, 0.13–0.16 and 1.15–1.30 (1.23) o.d. Lip angular (40°) in section, its lower surface convex, and its contour included in an inverted cone of 90°. Bowl 2.33–3.25 (2.72) o.d. in length, not sharply divisible into upper and lower cones approximately 0.74–0.78 and 0.26–0.22 of length of bowl with angles of 8–15° and 25–35°, respectively, gradually passing aborally into aboral horn. Pedicel tapering, conical, length and minimum diameter located just above knob, respectively, 1.77–2.86 (2.20) and 0.12–0.15 o.d., flaring distally into small knob, 0.17–0.30 (0.22) o.d. in diameter, varying from slight fusiform enlargement (Plate 17, fig. 9) to broad cone (Plate 17, figs. 5, 8) with rounded or angular skirt, and 6–8 spiral (40–50°) ribs across one face ascending to left. Lance 0.21–0.70 (0.47) o.d. in length, tapering above, cylindrical below, with a very slight distal flare at open tip, or cylindrical throughout, or with basal diameter twice distal (0.16 o.d.). Central canal of uniform calibre.

Wall nearly uniform except for thickening in suboral band and knob, with distinct yellowish brown color. Lamellæ equally thick, except for increase in inner one in suboral thickening, enclosing single layer of distinct, large, subuniform, rounded prisms, 5–6 across each intercostal space and 50–55 across one face on uppermost part of bowl, with no marked decrease in size in suboral ring, where there are 2–4 layers, larger and thicker-walled in knob, where there are 7–10 across one face. Ribs 16–25 (23.5), subvertical, leiotropic (20°), turned sharply to left and fading out below suboral shelf, equidistant, with frequent sinuosities and occasional bifurcations on lower cone and within 1 o.d. of rim or just below it, continuing on pedicel in re-

duced number (6–8), forming spiral ridges on knob. Fenestræ circular, about same size as larger prisms, with enclosing ring of lamellar substance with thickness less than diameter of opening, 8–15 (12) in one intercostal space, scattered irregularly but tending to be median below, rarely found on horn.

Ten loricæ: L., total, 222–298 (257.2); bowl, 114–143 (129.9); pedicel, 83–140 (105.0); lance, 10–32 (22.3). D., oral, 44–49 (47.8); lip, 55–62 (58.9); knob, 7–14 (10.5) μ.

At 10 stations, viz., at 3, 1, 1, 1, 1, 1, and 2, respectively, in California, Mexican, Peruvian and South Equatorial currents, Panamic Area, Galapagos Eddy, and Drift; at 69–83 (75.1)°; 116 loricæ.

Rhabdonellopsis longicaulis Kofoid and Campbell

Plate 16, figs. 4, 5, 7–9, 11–13; Plate 17, fig. 3

Lorica very elongate chalice-shaped, with slender, conical bowl and long, stout pedicel; 7.00–8.66 (7.70) o.d. Bowl, pedicel, and lance, respectively, 0.36–0.46 (0.43), 0.60–0.48 (0.52), and 0.04–0.07 (0.05) t.l. Oral rim very low, not over 0.03 o.d. in height, slightly flaring and somewhat thickened. Oral diameter 0.12–0.14 (0.13) t.l. Circumoral shelf with width of 0.12–0.15 o.d., and diameter to margin of lip of 1.13–1.27 (1.23) o.d. Circumoral gutter oblique in section, sloping in a shallow, concave depression to oral rim. Lip with same range in form as in *triton*, from one distinctly projecting to one with lower surface sloping more gradually into bowl; its margin angled (38°), with rounded edge, concave below. Suboral thickened region contained within an inverted cone of 90°. Bowl in many loricæ not separable into an upper and lower cone, because of gradual transition, but when definable, respectively, 0.6–0.7 and 0.4–0.3 length of bowl, with angles of 7–10° and 17–25°. Shoulder more evident in loricæ with less projecting suboral lip. Bowl 3.08–3.94 (3.34) o.d. in length, shorter than pedicel, with abrupt transition into aboral horn. Pedicel long, cylindrical, or stout subconical (5°), with length and diameter, respectively, 3.39–4.67 (3.58) and 0.09–0.11 o.d., longer than bowl, expanding into stout, heavy, dense knob, a truncate cone (20–25°), sometimes with rounded edges, but more often abruptly and squarely truncate, with ascending leiotropic (45–60°) spiral ribs on surface, forming projecting angles on its overhanging skirt, 0.20–0.43 (0.34) o.d. in diameter. Lancea slightly tapering, narrow cone, not over 5°, 0.31–0.51 (0.41) o.d. in length with basal diameter 0.3 that of knob, with slender axial canal running to truncate open tip. Wall hyaline, thickest in

suboral ring, decreasing gradually down bowl, thinning on pedicel and lance, thickening in knob, trilaminate, with equal lamellæ enclosing single layer of irregular and uneven prisms, with 2–3 in suboral ring and 2–5 in knob. Prisms smaller and denser at edge of suboral shelf, largest immediately below, smallest and most obscure in pedicel and lance, denser, and yellowish in knob, 5–8 between ribs in one intercostal space, and 65–100 across one face. Ribs less evident than in other species, sometimes scarcely visible in upper bifurcations and on pedicel and knob, 16–32 (21.3), bifurcating immediately below suboral shelf or in uppermost oral diameter of length, anastomosing rarely, subvertical, or leiotropic, not over 20°. Fenestræ minute, difficult to detect, circular or elliptical in outline, and often smaller than prisms, few in number, 4–8 in whole length of one intercostal space, irregularly distributed, tending to be median in lower bowl.

Ten loricæ: L., total, 350–468 (390.7); bowl, 147–213 (168.8); pedicel, 173–243 (201.1); lance, 15–25 (20.6). D., oral, 47–55 (50.5); lip, 57–70 (62.2); knob, 12–20 (17.1) μ.

In view of the minuteness of the fenestræ in this species, the Atlantic forms, reported by Brandt (1907) as devoid of these structures, should be reëxamined. Our Pacific form differs from Atlantic forms in presence of fenestræ, and longer pedicel (3.39–4.67 o.d., as compared with 2.25–2.65).

At 28 stations, viz., at 2, 1, 1, and 24, respectively, in Peruvian and South Equatorial currents, Easter Island Eddy, and Drift; at 67–81 (75.1)°; 147 loricæ.

Rhabdonellopsis minima Kofoid and Campbell

Plate 14, figs. 1, 3, 5; Plate 15, figs. 1, 7–9, 11–15

Rdps. minima, *partim*, K. and C., 1929, p. 224 (non fig. 423; see *Rdps. constricta* sp. nov.).

Lorica short chalice-shaped, with stout bowl, short pedicel, and fusiform knob; 2.95–4.85 (4.25) o.d. Bowl, pedicel, and lance, respectively, 0.55–0.69 (0.60), 0.40–0.28 (0.34), and 0.03–0.09 (0.06) t.l. Oral rim less than 0.03 o.d. in height, erect or slightly incurved. Oral diameter 0.21–0.34 (0.24) t.l. Circumoral shelf with width 0.14–0.20 o.d. and diameter to margin of lip 1.20–1.28 (1.22) o.d. Circumoral gutter shallow, concave, deepened next to rim. Lip angled (70°), sharp or slightly rounded at its entire or sinuous edge, with convex under surface, its contour contained within an inverted cone of 55–60°, thickened

suboral zone not over 0.3 o.d. in height. Bowl much longer (2.08–2.82 [2.53] o.d.) than pedicel, broadly tapering subconical (15–22°), with slight shoulder dividing it into upper and lower cones, 0.6–0.7 and 0.4–0.3 length of bowl and with angles of 10–18° and 30–42°, respectively. Transition into pedicel gradual. Pedicel concave subconical (10°), cylindrical in lower part, 0.08–0.10 o.d. in length, with least diameter 1.17–1.83 (1.46) o.d. Knob fusiform, evident because of density and color, 0.08–0.11 (0.10) o.d. in diameter, only a little greater than that of pedicel above it, with slight expansion in central canal. Lance short, stout, tapering (8°), 0.13–0.36 (0.27) o.d. in length, with a truncate, flaring, open tip. Wall thick, uniform on bowl, thinning in pedicel, but thickening in circumoral shelf, and in knob; trilaminate, with thin lamellæ enclosing 2 layers of minute, subregular, fairly uniform, very hyaline prisms in bowl, 10 across one intercostal space and 70–90 across one face, smaller in rim of circumoral shelf, increasing to 3–5 layers, and becoming larger, thick-walled, and yellowish in knob, forming there only a single layer, 8 across one face. Ribs 11–31 (20.9) in 25 loricæ, subvertical to leiotropic (10–15°), extending from circumoral shelf, turning below sharply to left on to pedicel, not forming ridges on knob, subparallel, nearly equidistant, branching occasionally near rim or on upper half of bowl, rarely anastomosing on lower bowl, very thin, hyaline, and delicate. Fenestræ circular or slightly elliptical, twice the size of prisms, located in little depressions in wall, 7–12 in one intercostal space, irregularly distributed, often in pairs, rarely extending upon pedicel, tending to a medium location in intercostal spaces on lower bowl.

Ten loricæ: L., total, 177–254 (209.5); bowl, 104–142 (124.5); pedicel, 56–102 (71.9); lance, 8–17 (13.1). D., oral, 47–52 (49.2); lip, 57–64 (60.4); knob, 4–6 (5.0) μ.

As shown by us (1929), this species has been confused, or at least combined, with *Rhabdonella spiralis* var. *hebe* (Cleve), and *Rdps. apophysata* and *triton*. The type locality selected by us was Sta. Pl. 35 of the Plankton Expedition in the Sargasso Sea; Brandt's figure (pl. 53, fig. 6) from this station therefore represents the type. We (1929, p. 222, fig. 423) also published a figure assigned to this species from Sta. 4712. This figure we now remove from *minima* and make it the type of *Rhabdonellopsis constricta*, for reasons apparent in the discussion of that species.

At 34 stations, viz., at 11, 1, and 22, respectively, in Easter Island and Galapagos eddies and Drift; at 68–79 (73.3)°; 1012 loricæ.

Rhabdonellopsis triton (Zacharias) Kofoid and Campbell

Plate 16, figs. 2, 3, 6, 10; Plate 17, figs. 1, 2, 4

Lorica very tall, slender chalice-shaped, with short conical bowl and very long, slender pedicel; 5.61–9.04 (7.23) o.d. Bowl, pedicel, and lance, respectively, 0.41–0.50 (0.46), 0.51–0.42 (0.46), and 0.06–0.11 (0.08) t.l. Oral rim thin, hyaline, erect, or slightly everted, not exceeding 0.03–0.04 o.d. in height above gutter. Oral diameter 0.11–0.18 (0.14) t.l. Circumoral shelf with width of 0.12–0.16 o.d., and diameter to margin of lip of 1.18–1.30 (1.26) o.d., resulting in a concave conical contour to suboral region. Circumoral gutter shallow, asymmetrically concave, deeper near rim. Suboral lip relatively very short, with subangular (33°), broadly rounded, sinuous edge, with concave conical contour below. Suboral thickening contained within an inverted cone of 55°, not exceeding 0.16 o.d., merging abruptly into wall. Bowl 2.77–3.81 (3.30) o.d. in length, with upper and lower cones scarcely delimited by a shoulder, 0.66 and 0.33 lengths of bowl, with angles of 5–15° and 22–32°, respectively. Pedicel 2.37–4.31 (3.35) o.d. in length and about 0.1 in diameter above knob, a tapering cone of 5–10° in upper part, expanding a short distance above knob. Knob 0.19–0.26 (0.23) o.d. in diameter, inverted subconical (18–33°), truncate or rounded below, or broadly fusiform, somewhat irregular or asymmetrical, its surface ribbed with ascending left-wound spiral (45°) ribs, 4–6 across one face, being continuations of ribs of pedicel or interpolations between them, its lower surface more often truncate than rounded, even excavated, with ridges forming projections, as in *Xystonellopsis pulchra*. Lance 0.46–0.69 (0.58) o.d. in length, 0.33 diameter of knob in diameter, nearly cylindrical, with squarely truncate, open end, with central canal enlarged in knob. Wall thin, 0.033 o.d. in thickness, very hyaline, fairly uniform, thicker in suboral rim and knob, trilaminate, with equal lamellæ enclosing a single layer of faint, subuniform, subregular prisms, 8–10 between ribs and 90–100 across one face, with 2–4 layers in suboral ring, and 2–3 larger ones in knob, denser in suboral rim and knob, and yellowish in latter. Ribs 14–26 (19.9), very distinct, almost longitudinal, with branches deflected to left, extending from rim of suboral shelf to pedicel, knob, and even upper part of lance, often curving abruptly to left at suboral shelf, occasionally bifurcating near it, with branches only slightly connected with parent rib, main branches occurring about midway or in upper half of bowl, and anastomoses, or reunions, rarely seen on middle or lower half. Fenestræ minute, 18–26 in one intercostal space, extending upon pedicel, irregularly distributed

on upper bowl, tending to lie in a single, median intercostal line below. Animal with 2 large, elongate, ellipsoidal macronuclei, 9 by 18μ, with adjacent globular micronuclei of much smaller size. Body subconical, rather short, with peduncle twice as long as bell-shaped cytosome, attached to one side of lower end of bowl.

Ten loricæ: L., total, 275–452 (367.2); bowl, 136–198 (167.4); pedicel, 136–224 (170.3); lance, 24–36 (29.5). D., oral, 46–52 (50.8); lip, 58–69 (63.9); knob, 10–13 (11.5)μ.

Its history is a long and confused one. First figured by Zacharias (1906, fig. 8) who had loricæ 330–340μ in length, but with the essential features of the species. Our material is similar to Brandt's (pl. 51, figs. 5–7), though it runs somewhat larger, 275–452μ, as compared with 280–410μ, appears to have more striæ (14–26) than Brandt records (12–16).

At 46 stations, viz., at 2, 2, 9, 2, 2, 2, 7, 4, and 16, respectively, in California, Mexican, Peruvian, South Equatorial, Equatorial Counter, and North Equatorial currents, Panamic Area, Galapagos Eddy, and Drift; at 67–83 (74.4)°; 200 loricæ.

X. XYSTONELLIDÆ Kofoid and Campbell emended

Cyttarocylidæ, *partim*, K. and C., 1929, p. 108 (see also Cyttarocylidæ and Ptychocylidæ).

Favellineæ, *partim*, K. and C., 1929, p. 116 (for Porœcus, Favella, Cymatocylis, and Protocymatocylis see Ptychocylidæ).

Tintinnoinea with lorica elongated, chalice-shaped; oral margin entire, toothed, thinned down to sharp edge, or flat and channeled as circumoral shelf; suboral differentiation lacking, or developed as thickened band, with straight or sigmoid outer slope; or with 1–3 rings; bowl elongated, divisible into upper cylinder or inverted cone and lower inverted cone; aboral region with simple aboral horn or differentiated in pedicel and lance, or pedicel with its lower end in knob with angled apophyses at its truncated lower edge, or skirt; aboral end closed, with a canal to tip of lorica; wall trilaminate, with inner and outer double-contoured lamellæ and prismatic intermediate layer with secondary structure and usually also fine primary structure; no closing-apparatus [?]; marine, eupelagic, and usually very common in temperate and tropical seas.

Includes four large and dominant genera, three from tropical plankton: Parundella (23 species); Xystonella (9); Xystonellopsis (34); and one, Parafavella (23), from northern seas.

The removal of Parafavella to this family leaves the Ptychocylidæ free from all forms in which large secondary prismatic structure is prominent. This reallocation also results, in part, in the suppression of the former subfamily Favellinæ, which we (1929) included in the Cyttarocylidæ. This results in greater homogeneity in the families concerned.

24. PARUNDELLA Jörgensen emended Kofoid and Campbell

Xystonellidæ with an elongated lorica with upper cylinder, lower cone, and aboral horn; oral margin entire or toothed, thinned to sharp edge; suboral thickening slight, never forming circumoral shelf or suboral lip, rarely with even sigmoid outline; bowl cylindrical above, conical below; aboral horn or spine present, except in *P. acuta;* wall usually clearly trilaminate, homogeneous or with primary structure in middle layer, its inner and outer lamellæ double-contoured, usually closely approximated and fused aborally; eupelagic, marine, in temperate and tropical seas. Type species *Parundella lachmanni* (Daday) K. and C. from Atlantic. Claparède and Lachmann (1858, p. 210, pl. 9, fig. 56) first figured this as Tintinnus sp. from the radiolarian Thalassicola sent to them from the tropical Atlantic. Brandt (pl. 64, fig. 26) figured this species, to which Daday (1887b, p. 568) assigned the name *lachmanni*, not having seen the species. Two of Brandt's loricæ came from Station Pl. 25 of the Plankton Expedition in margin of Labrador and Florida currents, which may serve as the type locality.

Established by Jörgensen (1924) as a subgenus of Undella, with 4 species: *caudata, aculeata* and var. *longa, lohmanni,* and *messinensis.* We (1929) reorganized it; raised it to generic status; added 12 new species; transferred to it *Tintinnus translucens* Wailes (1925) and its two varieties *major* and *minor,* raising them to specific status; accepted *Undella lachmanni* as a Parundella, a species which Jörgensen (1924) had rejected but Brandt (1906, 1907) had reestablished; and restored Jörgensen's (1899) early species, *Undella pellucida,* which he (1924) had included in his *U. p. caudata,* to specific autonomy as *P. pellucida.* A total of 23 species were thus assigned to this genus.

Differs markedly from the related Xystonella in absence of a channeled oral rim, simpler form, and feeble development of the intermediate prismatic layer. Relationships to Xystonella appear in the general form of the *P. minor* series and in wall structure of the larger *P. pellucida* series. Relationships to Favella are suggested by the aboral striæ of *P. messinensis* and the fins of *P. caudata,* as well as by

wall structure. The aboral linear differentiation suggests the Salpingellinæ.

Perhaps the most significant of all the structural relationships is seen in the striking similarity between the form and proportions of the simpler species of the *P. minor* series to those of the smallest and simplest species of the primitive genus Tintinnopsis. This appears in a comparison of *P. minor* with *Tintinnopsis rapa* and *Tps. acuminata* (see K. and C., 1929, figs. 24, 43). The wall structure differentiates Tintinnopsis from Parundella, and this characteristic is almost lost in *Tps. acuminata.* Parundella differs from Parafavella in the absence of strongly developed secondary prismatic structure and circumoral teeth, and in the smaller size of its species.

Relationship with Xystonellopsis is clearly indicated through the subgenus Parundellopsis, both having undifferentiated suboral regions and stout loricæ. The subgenus Parundellopsis has a pedicel, skirt, and lance, which are lacking in Parundella. *Parundella clavus* and *P. aculeata* suggest *Xps. turgida.* As in Protoxystonellopsis, another subgenus of Xystonellopsis, there is no evidence in Parundella of a skirt or knob of a pronounced character. It is thus evident that Xystonellopsis and Parundella have had close connections, or even a common origin from some yet simpler, more primitive form.

Includes 23 species, 14 from the Expedition material. Of these 23 species 12 were described by us (1929) as new, and 10 others were present in Expedition material. Another new species, *elongata,* is added and *aciculifera* is transferred from Favella in this report. Subdivided into four series: the *minor* series, including *minor, grandis, lachmanni, translucens, lagena, major, longa,* and *elongata;* the *clavus* series, including *clavus, inflata,* and *invaginata;* the *aculeata* series, including *aculeata, aciculifera,* and *acuta;* and the *pellucida* series, including *pellucida, prætenuis, difficilis, humerosa, caudata, messinensis, gigantea, lohmanni,* and *attenuata.*

Parundella aciculifera (Jörgensen)

Plate 18, figs. 12, 16

P. spinosa K. and C., 1929, p. 233, fig. 435.

Favella aciculifera Jörgensen, 1924, p. 31, fig. 35; K. and C., 1929, p. 149, fig. 282.

Lorica stout, tall cylindrical goblet-shaped; 2.81–3.77 (3.25) o.d. Oral margin thin, rounded, slightly inflexed, flaring (45°) below with a concave slope in a more or less thickened suboral ring, with broadly

rounded shoulder 0.25–0.30 o.d. below oral margin, 0.14–0.18 o.d. in thickness. Bowl below ring subcylindrical, with slight contraction below suboral ring, and slight aboral expansion, with diameters in contracted and expanded regions, respectively, of 1.15– and 1.17–1.40 (1.27) o.d. Aboral end a low cone of 110–130°, or almost hemispherical. Aboral horn with basal conical section (25°) 0.2 o.d. in length, with a thin perforated septum at its base, passing at once into a slender acicular, solid lance 0.28–0.86 (0.63) o.d. in length. Wall extraordinarily thick but not uniform; in loricæ without marked suboral ring fairly uniform (0.08–0.10) to level of aboral contraction, thinning rapidly thence to the very thin-walled basal cone (0.02); in loricæ with a suboral ring (0.16) it thins to 0.08 a short distance below ring, gradually thickening (0.16–0.20) to widest part of bowl, and thinning rapidly distally to basal cone. Wall 1.3μ in thickness, enclosing very distinct secondary prisms radially placed, hexagonal in section, with some indication of an arrangement in an ascending leiotropic spiral steeper in lower part of bowl; not decreasing in diameter in oral rim, but with radial diameter shortened here and in distal third of aboral end of bowl; quite regular in form and uniform in size at each level, about 25–30 across one face, slightly larger on ring, smaller in neck, and larger again on expanding slope of bowl, decreasing distally on aboral end of bowl. No secondary prisms visible on basal cone or lance of aboral horn. Animal fills lower half of bowl, with 18 membranelles, 2 ellipsoidal macronuclei, and 2 small ellipsoidal micronuclei.

Ten loricæ: L., total, 101–132 (113.9); horn, 10–30 (22.3). D., oral, 33–36 (35.1); suboral ring, 40–45 (43.2); bowl, 42–50 (44.5)μ.

We (1929, p. 148) previously included Jörgensen's species (1924, fig. 35) in Favella, following his placement, but now transfer it to Parundella, where it clearly belongs. We also described (1929, p. 233, fig. 435) some forms of this species as *Parundella spinosa*, but they are so similar to Jörgensen's species that *Parundella spinosa* falls into the synonymy of *P. aciculifera* (Jörgensen).

At 30 stations, viz., at 1, 9, 2, 2, 2, and 14, respectively, in Mexican and Peruvian currents, Panamic Area, Easter Island and Galapagos eddies, and Drift; at 66–85 (76.4)°; 50 loricæ.

Parundella aculeata Jörgensen

Plate 17, fig. 12

Lorica elongate, cylindrical chalice-shaped, forming an angle 15–18° measured from tip to rim, consisting of a bowl and horn; 3.66–4.08

(3.88) o.d. Oral margin rounded, with little flare from within outward. No suboral band or lip. Bowl 2.70–3.18 (2.88) o.d. in length, with upper 0.55–0.60 almost cylindrical, with very little increase in diameter (not over 0.1) aborally, lower 0.45–0.40 convex conical (45–50°), with no shoulder. Transition into horn abrupt. Aboral horn attenuate conical (9–11°), with thick walls and a sharp, closed tip; 0.83–1.21 (0.94) o.d. in length, with basal diameter 0.16–0.22 its length, and central canal occluded in distal 0.5. Wall subuniform throughout, thinning slightly aborally.

Five loricæ: L., total, 108–114 (110.8); bowl, 80–86 (82.4); horn, 24–34 (27). D., oral, 27–30 (28.6); greatest, 29–33 (30.6); horn, 4–5 (4.6) μ.

At 24 stations, viz., at 1, 1, 1, 3, 2, 2, and 14, respectively, in the Mexican, Peruvian, and South Equatorial currents, Panamic Area, Easter Island and Galapagos eddies, and Drift; at 68–85 (75.7)°; 46 loricæ.

Parundella acuta Kofoid and Campbell

Plate 18, figs. 6, 8

Lorica stout, constricted subcylindrical goblet-shaped; 2.35–2.56 (2.47) o.d. Oral margin bluntly rounded. Oral rim with vertical inner and concave outer slope in a cone of 45°. Suboral thickened ring very broadly rounded, vertical height (0.35 o.d.), 2–3 times its thickness. Bowl below ring with vertical or flaring (5°) sides. Aboral 0.33–0.50 of bowl bulging, rotund, with a slight increase in lumen, and more in external diameter, due to thickened walls; greatest diameter 1.11–1.32 (1.23) o.d., located 0.88–1.06 (0.94) o.d., or 0.6 total length, from tip. Aboral end of bowl conical to slightly rotund, forming an inverted cone of 65–75°. Aboral horn 0.10–0.18 o.d. in length, not differentiated by slope but by thin wall and perforate septum. Tip acute, closed. Wall very thick, with radially elongated, secondary prismatic polyhedrons of regular uniform pattern and size at each level; with thickness at oral ring, below ring, on the greatest diameter of bowl, and on aboral horn 0.14, 0.09, 0.18, and 0.04 o.d., respectively. Towards oral rim and tip secondary prisms disappear between fusing lamellæ, the aboral horn being formed of their substance in one layer, delimited internally by thin, upwardly directed, convex, internal septum. Prisms 45 across one face on suboral ring, almost as many in constricted region below, and 80 on widest part of bowl, growing smaller distally and difficult to detect, with a slight trace of a spiral arrangement with increasing obliquity aborally.

Six loricæ: L., total, 80–90 (84.8); from aboral bulge to tip of axis, 30–36 (32.3). D., oral, 34–36 (34.3); greatest, 40–45 (42.3) μ.

At 7 stations, viz., at 1, 2, and 4, respectively, in Peruvian Current, Galapagos Eddy, and Drift; at 68–79 (77.2)°; 7 loricæ.

Parundella attenuata Kofoid and Campbell

Plate 18, fig. 19

Lorica very large, greatly elongated, cylindrical goblet-shaped, prominent suboral ring; 3.71–4.25 (3.91) o.d. Oral margin thin, bluntly rounded. Oral rim with little flare (4°), with convex inner and concave outer slope. Suboral thickened zone distinct, attaining greatest thickness (0.07 o.d.) at 0.33 o.d. below oral margin, thinning abruptly below to normal wall, with diameter on suboral ring 1.13 o.d. Bowl with upper subcylindrical and lower conical (30–43°) regions, 2.0 and 0.9 o.d. in length, respectively; with very slight contraction through middle 0.5, with a trace of inflation at lower end of upper part, but never forming a localized ring, and not attaining diameter of suboral thickening. Upper part passing abruptly into convex subconical (30–43°) lower part, which in turn passes abruptly into horn. Basal part of horn conical (9–13°), 1.02–1.19 o.d. in length, with upper and lower diameters, respectively, of 0.28–0.33 and 0.12–0.10 o.d., with 10 short (0.4 o.d.) longitudinal ridges on some loricæ. Lance very short conical (35°), 0.16 o.d. in length, with its basal diameter nearly equaling its height. Wall thin, 0.1 o.d. in thickest part of suboral thickening, thinning distally in lower bowl, slightly thicker in horn, and very thin in lance, with same structure as in *messinensis*.

Nine loricæ: L., total, 162–205 (190.6); bowl, 118–150 (137.1); basal horn, 36–50 (45.5); lance, 7–9 (8.0). D., oral, 47–52 (48.8); fundus, 45–50 (49.2) μ.

At 20 stations, viz., at 3, 1, 2, 3, and 11, respectively, in Peruvian and South Equatorial currents, Galapagos and Easter Island eddies, and Drift; at 66–81 (74.2)°; 26 loricæ.

Parundella caudata (Ostenfeld) Kofoid and Campbell

Plate 21, fig. 14

Lorica very tall, slender, subconical chalice-shaped, without suboral band or lip; subtending as a whole an angle of 12–16°; 3.94–4.43 (4.09) o.d. Oral margin acute in section, convex on both slopes, with outward

flare of inner face of 15°. Suboral thickening not distinctly localized, reaching a maximum of 0.1 o.d. within 0.5 o.d. of rim, thinning down to normal wall within 1.0 o.d. Bowl 2.90–3.27 (3.03) o.d. in length; its upper part 0.4–0.5 total length, or 0.55–0.60 length of bowl, or 1.75–2.00 o.d. in length, cylindrical or subcylindrical, with inflation above lower cone to 1.04 o.d. Lower part convex-subconical (30–42°), 1.25–1.50 o.d. in length. Transition into horn abrupt. Basal horn 0.50–0.77 (0.61) o.d. in length, conical (17–24°), its upper and lower diameters, excluding lists, respectively, 0.20–0.27 and 0.16–0.12 o.d. Wide angle between horn and bowl filled by 4–5 short prismatic lists, preserving the general conical outline. Lists vertical, 0.5–0.8 o.d. in length, and disappearing above on lower cone and below on horn. Basal horn passing without ledge directly into thin-walled lance, less clearly distinguishable in optical section by thinning of wall than in *messinensis*, its conical contour continuing that of basal horn, 0.39–0.53 (0.45) o.d. in length, and basal diameter 0.3 its length. Tip sharp, closed. Wall somewhat thicker in upper 0.3, thinning in lower cone, thickening again in upper horn, and thinning to a single fused lamella in lance, formed by minute primary prisms between thin inner and outer lamellæ, regular and uniform throughout whole lorica, forming hexagonal fields in surface view, and extending out into lists, 4 layers in the thickest part, 3, 2, and 1 down the bowl into lower cone, 2 in horn, and none in lance, 65–70 across one face on cylindrical part of bowl.

Eight loricæ: L., total, 120–139 (129.5); bowl, 87–102 (95.9); basal horn, 16–23 (19.4); lance, 12–17 (14.3). D., oral, 30–34 (31.6); greatest, 30–34 (32.5) μ.

At 22 stations, viz., at 1, 1, 8, 1, 2, and 9, respectively, in California, Mexican, Peruvian and Equatorial Counter currents, Galapagos Eddy, and Drift; at 65–84 (71.6)°; 41 loricæ.

Parundella clavus Kofoid and Campbell

Plate 18, figs. 1, 10

Lorica small, stout, conical goblet-shaped; 2.78–3.35 o.d.; contained within a cone of 12° from rim to tip; anterior half almost cylindrical, posterior subconical (32°), with a stout, pedicel-like aboral extension. Oral rim slightly everted on inner face, very slightly concave on outer. Suboral band broad, extending 0.8 o.d. below oral rim, merging gradually into wall below. Bowl, including stout, subcylindrical, pedicel-like terminal part, 2.3–2.4 o.d. in length; upper part subcylindrical and convex outwardly, 1.0 o.d. in length; lower part an inverted truncated

cone (36°), 1.0 o.d. in length. Lower cone subcylindrical below for 0.5 o.d., forming a short pedicel with slight aboral expansion formed by inflation of intermediate layer of wall. Aboral end of pedicel abruptly contracted in an inverted cone of 110°, with rounded angle. Aboral horn tapering (20°), slender, with length and basal diameter, respectively, of 0.5–0.8 and 0.16 o.d., with central canal for 0.3–0.6 its length. Wall unique in Parundella in restriction of secondary radial prisms to suboral band, where there are 12–40 in vertical direction and 37 across one face, and in aboral inflation of prismatic layer. Prisms always faint; inner and outer lamellæ closely appressed except in suboral zone and inflated region at base of pedicel. Wall with a brownish tint in pedicel.

Two loricæ: L., total, 78–87; horn, 14–22. D., oral, 26–28; suboral band, 28–29; pedicel, 12–13 μ.

At 2 stations, viz., at 1 each in Easter Island Eddy and Drift; at 75–79 (77)°; 2 loricæ.

Parundella difficilis Kofoid and Campbell

Plate 18, figs. 13, 17

Lorica elongate, slender chalice-shaped, nearly cylindrical in upper 0.5, and tapering in lower, consisting of a bowl with an awl-shaped horn; 2.87–3.50 (3.30) o.d. Oral margin sharp, with rim slightly everted and concave externally. Suboral thickening increasing gradually, slight, fading out within 0.5 o.d. below rim, and widest (1.08 o.d.) below middle. Bowl 2.05–2.43 (2.30) o.d. in length, consisting of upper, nearly cylindrical section of 1.22–1.48 (1.38) o.d. in length, and convex conical (31–43°) lower one a trifle less than 1 o.d. in length, passing gradually distally with change of curvature into horn. This transition is all but obliterated in the lorica figured (Plate 18, fig.13); some loricæ with slight median concavity of upper section and a slight expansion below, as in *lohmanni*. Basal part of aboral horn 0.5 o.d. in length, with a diameter at its upper and lower ends, respectively, of 0.28–0.40 and 0.16–0.12 o.d., concave subconical (15–23°) without [?] surface striæ, terminating distally in attenuate, conical (11–18°), thin-walled, sharp, pointed lance, 0.27–0.52 (0.43) o.d. in length, and a basal diameter 0.25–0.45 its length. Tip sharp, closed. Wall thickest in suboral region, less than half as thick elsewhere, and reduced to a single, fused lamella in lance, enclosing very fine, delicate hexagonal prisms between lamellæ in 4 or more rows across suboral thickening, and elsewhere in 3, 2, and 1 layer.

Eight loricæ: L., total, 112–133 (116.1); bowl, 74–87 (82.1); basal part of horn, 12–29 (18.8); lance, 10–17 (15.2). D., oral, 33–38 (35.7); suboral ridge, 37–41 (38.9)μ.

At 29 stations, viz., at 9, 1, 2, 1, and 16, respectively, in Peruvian and South Equatorial currents, Easter Island and Galapagos eddies, and Drift; at 65–81 (73.2)°; 51 loricæ.

Parundella elongata spec. nov.

Plate 17, fig. 9

Lorica slender, subconical (10°) awl-shaped; 5.9 o.d. Oral region for 0.27 o.d. from rim with an increased flare forming an inverted cone (25°). Oral margin rounded externally. No thickened suboral band, the wall being only a trifle thicker toward oral end. Bowl 0.42 t. l. length, subconical, widest at oral rim, 3.5 o.d. in length; upper bowl an inverted concave cone of 7°, forming 0.72 length of bowl; the lower forming 0.28 length of bowl, a short inverted cone of 21°; passing very gradually with slight change in curvature into undifferentiated aboral horn, 0.28 t. l. in length and a slightly concave inverted cone (9°) with basal diameter 0.14 its length; its contour slightly sinuous in its distal third, with 7 low, longitudinal, dexiotropic (10°) striæ extending from lower end of bowl almost to tip. Aboral end blunt, closed. Wall thickest in suboral and aboral regions, thinner elsewhere, with small prisms, without localised increase in size.

L., total, 177; bowl, 104; pedicel-lance, 73. D., oral, 30; top of aboral horn, 10μ.

At Sta. 4659, in Peruvian Current; at 69°; 1 lorica.

Parundella gigantea Kofoid and Campbell

Plate 18, figs. 7, 18

Lorica stout, subconical chalice-shaped, with upper 0.75 of bowl subcylindrical and lower 0.25 abruptly concave conical; 2.89–3.27 (3.10) o.d. Oral margin angled. Oral rim flaring (15°) outwardly on inner face with outer face subvertical. Suboral thickened zone undeveloped, forming a vaguely limited band 0.4 o.d. in length, attaining its greatest diameter (1.09 o.d.) at 0.31 o.d. below rim. Bowl 1.95–2.32 (2.18) o.d. in length, with median zone of slight constriction to 0.98 o.d. in some loricæ, but expansion below slight, upper subcylindrical (6°) part up to 0.75, and lower subconical (47–58°), 0.25 length of bowl. Transition into horn abrupt. Basal part of aboral horn

subconical (12–18°), 0.29–0.66 (0.48) o.d. in length, with upper and lower diameters, respectively, of 0.28–0.33 and 0.16–0.12 o.d., with concave sides and feeble, longitudinal, vertical or dexiotropic (9–12°) striæ on its surface. Lance with a slight shoulder, attenuate conical (14–20°), 0.38–0.53 (0.44) o.d. in length, and basal diameter 0.25–0.35 its length. Tip sharp, closed. Wall thickest in suboral zone at 0.3 o.d. below rim, thinning in lower cone, and to only a single fused lamella in lance. Regular, equidistant secondary prisms in one layer clearly defined in upper suboral region, each enclosing four layers of primary prisms, decreasing in lower bowl and horn from 3 to 1 layers, with three layers in the striæ.

Five loricæ: L., total, 127–157 (144.6); bowl, 82–112 (101.6); basal part of horn, 13–25 (22.4); lance, 20–22 (20.6). D., oral, 38–53 (46.6); suboral, 42–55 (49.0); midway, 30–45 (40.6) μ.

At 9 stations, viz., at 1, 4, 1, and 3, respectively, in Peruvian Current, Panamic Area, Galapagos Eddy, and Drift; at 66–81 (76.0)°; 12 loricæ.

Parundella humerosa Kofoid and Campbell

Plate 17, figs. 14, 15; Plate 18, fig. 11

Lorica medium stout, rotund chalice-shaped, with well developed suboral zone, stout horn, and shouldered lance; 2.66–3.14 (2.91) o.d. Oral margin thick, rounded. Oral rim flaring outwardly 14° from vertical, convex on inner and concave on outer face, thinning abruptly on outer face only. Suboral thickening localized in a low, rounded swelling 0.12–0.16 o.d. in thickness, at 0.25 o.d. below rim, 0.4 o.d. in length, and 1.04–1.14 (1.11) o.d. in diameter. Bowl 1.89–2.11 (1.95) o.d. in length, without median constriction or distal expansion, consisting of subcylindrical upper portion, 0.65 length of bowl and 0.5 t. l., and short subconical (36–47°) convex lower cone passing abruptly into horn. Basal part of aboral horn short, conical (18-22°), 0.39–0.47 (0.44) o.d. in length, with upper and lower diameters, respectively, of 0.25–0.40 and 0.20–0.14 o.d., without (?) striæ, with distinct subangular shoulder marking transition into slender, thin-walled conical (12–14°) lance, 0.22–0.61 (0.49) o.d. in length, with basal diameter 0.33 its length. Tip sharp, closed. Wall thickest across suboral band, thinning in lower cone, somewhat less in upper horn, and to a single fused lamella in lance; formed by minute prisms between inner and outer lamellæ, regular and uniform throughout lorica, appearing as hexagonal fields across upper bowl; with 4 layers

in upper bowl, and 1–3 in a descending series in lower cone and upper horn, with none in lance.

Four loricæ: L., total, 108–125 (114.0); bowl, 72–88 (77.0); basal horn, 15–22 (17.5); lance, 15–23 (19.5). D., oral, 36–47 (39.5); suboral thickened zone, 41–49 (43.8) μ.

At 8 stations, viz., at 3, 2, 2, and 1, respectively, in Peruvian Current, Easter Island and Galapagos eddies, and Drift; at 69–75 (72.7)°; 8 loricæ.

Parundella inflata Kofoid and Campbell

Plate 17, figs. 7, 11

Lorica much elongated, chalice-shaped, a cone of 14–16° measured from tip to rim, consisting of bowl and horn; 3.56–4.35 (3.92) o.d. Oral rim rounded, entire; no lip or external concavity, suboral thickening slight, 1.0 o.d. in length. Bowl 2.65–3.45 (2.91) o.d. in length; upper section subcylindrical, 0.45 length of bowl, increasing to not more than 1.16 o.d. at lower end; lower section an inverted segment of a convex cone (30–40°), with slope suddenly increasing in aboral 0.16–0.33 to 60–90°, forming an abrupt shoulder above horn. One lorica with low lists in angle between horn and bowl. Horn a very slender, attenuate cone (8°), 0.88–1.24 (1.00) o.d. in length, basal diameter 0.05–0.14 length, with narrow central canal in upper 0.3 to whole of horn. Tip sharp, closed.

Seven loricæ: L., total, 92–126 (104.7); bowl, 69–100 (77.7); horn, 22–34 (27.0). D., oral, 25–29 (26.7); greatest diameter, 25–31 (28.1); horn, 2–5 (3.7) μ.

At 18 stations, viz., at 1, 3, 1, and 13, respectively, in South Equatorial Current, Easter Island and Galapagos eddies, and Drift; at 68–81 (75.7)°; 28 loricæ.

Parundella invaginata Kofoid and Campbell

Plate 18, fig. 4

Lorica strikingly stout goblet-shaped, with tall cup-shaped bowl, telescoped pedicel, and stout conical horn; 2.27–2.77 (2.53) o.d. Oral rim sharpened by gradual outward flare of inner lamella, beginning 0.16 o.d. below rim, with convex inner surface. No suboral thickening. Bowl measured to aboral ring 1.41–1.95 (1.76) o.d. in length, subcylindrical, with slightly convex sides up to 1.05 o.d. near middle, contracting aborally at 1.00–1.25 o.d. from rim, with rounded shoulder

in a cone of 50–60° into pedicel. Pedicel up to 0.2 o.d. in length, inverted conical (15°) or flaring (8°), with overhanging ridge shaped as though formed by thrusting of aboral horn into base of bowl, with more or less of telescoping of lower part of pedicel into upper part, resulting in some loricæ merely in a raised local angular ridge, while in others invagination has a vertical depth of 0.2 o.d., with salient, rounded ring, 0.39–0.50 (0.44) o.d. in diameter. Pedicel contracting below ring (20–40°) to concave conical aboral horn with upper part extending aborally for 0.22–0.28 o.d., then passing over into slender, thin-walled, attenuate, subconical (10–17°) lance, 0.45–0.65 o.d. in length, with basal diameter 0.25–0.33 its length. Junction between pedicel and horn not marked by any knob or thickening of wall. In many loricæ transition of horn to lance without change in slope, while in others there is a slight shoulder, but in all cases transition marked by abrupt thinning of wall, with fusion of inner and outer lamellæ. Tip sharp, closed. Wall thickest below oral region, thinning gradually towards ring, where it thickens slightly, thinning out in thin-walled lance; formed of thin inner and outer lamellæ enclosing an exceedingly fine prismatic meshwork, crowded out in lance. Body relatively large, nearly filling upper 0.75 of bowl, with 20 membranelles and 2 oval macronuclei, 7 by 14 μ.

Ten loricæ: L., total, 100–122 (107.1); to ring on pedicel, 70–80 (74.6); lower pedicel and horn, 28–42 (32.5). D., oral, 41–44 (42.4); ring, 17–22 (18.5) μ.

At 15 stations, viz., at 7, 1, 2, 2, and 3, respectively, in Peruvian and South Equatorial currents, Panamic Area, Galapagos Eddy, and Drift; at 65–80 (72.2)°; 27 loricæ.

Parundella messinensis (Brandt) Jörgensen emended Kofoid and Campbell

Plate 18, fig. 15

Lorica tall cylindrical goblet-shaped, with bowl abruptly angled at junction of upper subcylindrical and lower conical regions; 3.34–3.61 (3.49) o.d. Oral margin bluntly rounded, flaring outwardly (5°), with vertical or concave outer and convex inner slope. Suboral expansion restricted, slight, not over 1.15 o.d., fading out gradually within upper third of bowl. Bowl subcylindrical, 2.35–2.64 (2.55) o.d. in length, forming 0.70–0.74 (0.72) t. l., consisting of upper subcylindrical part, 2 o.d. in length, and a lower cone (50–60°) 0.5 o.d. in length, upper contracting slightly below middle to 1 o.d., expanding distally to fundus

where slope changes abruptly to a rounded projecting ridge, as in Brandt's lorica (pl. 69, fig. 13). Fundus, or bottom level of subcylindrical section, expanded to 1.00–1.08 o.d., with rounded outer angle. Lower cone deeply concave, 100° above, contracting to 60° below. Transition into horn gradual. Basal part of aboral horn 0.63–0.77 (0.73) o.d. in length, concave conical (10–15°), its upper and lower diameters, respectively, 0.3–0.4 and 0.18–0.15 o.d., with low vertical longitudinal ridges, often interrupted, extending up over angle of fundus, 10 main ridges on basal horn and 20–30 short runs interpolated on lower cone, formed by slight folds of outer lamella. Lance 0.19–0.37 (0.25) o.d. in length, conical (14–26°), with thin walls, with base 0.28–0.50 its length and sometimes a slight shoulder at junction with basal part of horn. Tip sharp, closed. Wall very thin, thickest in upper and lower expansion of bowl, very thin in contracted portion and lower cone, and thinnest in the lance, with 2–4 layers of minute regular prisms forming in surface view hexagonal primary fields; uniform throughout whole lorica, 80 across one face of bowl, with 2, 4, 2, 4, 2, and 0 layers, respectively, in oral lip, suboral thickening, contracted region, fundus expansion, lower cone, and lance.

Five loricæ: L., total, 147–156 (152); bowl, 106–116 (109.2); base of aboral horn, 28–36 (31.8); lance, 7–12 (11). D., oral, 41–46 (43.3); fundus, 44–48 (46.2) μ.

At 15 stations, viz., at 3, 2, and 10, respectively, in Peruvian Current, Galapagos Eddy, and Drift; at 68–79 (73.2)°; 23 loricæ.

Parundella prætenuis Kofoid and Campbell

Plate 17, fig. 13

Lorica medium slender conical chalice-shaped, with slender horn; 2.28–3.20 (2.71) o.d. Oral margin bluntly rounded, with slight inner flare and less concavity on outer slope in a cone of 15°. Suboral thickening 0.6 o.d. in length, with slight shoulder below. Bowl below thickened zone 1.56–2.23 (1.93) o.d. in length; with upper and lower cones subequal in length, each an inverted segment of a cone of 15° and 42–50°, respectively. Lower concave cone passing with slight change in curvature into horn. Aboral horn with short subconical (12–21°) basal part, 0.34–0.51 (0.41) o.d. in length, without striæ, with diameters at upper and lower ends, respectively, 0.20–0.28 and 0.10–0.07 o.d., passing distally into attenuate, thin-walled, conical (13–16°) lance, 0.27–0.48 (0.38) o.d. in length and basal diameter 0.25–0.30 its length. No septum. Tip acute, closed.

Six loricæ: L., total, 89–113 (97.1); bowl, 61–78 (69.5); base of horn, 12–19 (14.8); lance, 10–17 (13.0). D., oral, 34–39 (36.0); suboral, 35–41 (37.8) μ.

Larger loricæ (107–113 μ) occur at temperatures of 69–75 (72)°, and smaller ones (89–94 μ) at 72–80 (74)°.

At 9 stations, viz., at 3, 2, and 4, respectively, in Peruvian Current, Panamic Area, and Drift; at 69–80 (73.4)°; 13 loricæ.

25. XYSTONELLA Brandt emended Laackmann emended Jörgensen

Xystonellidæ with lorica subconical, very long and narrow; oral margin thickened, flattened, with trough on horizontal surface between inner and outer lamellæ, outer more or less flaring, entire or toothed, and inner erect and entire; bowl elongate, vase-shaped, or inverted conical, with upper and lower cones; prolonged aborally, either in an undifferentiated aboral horn, or in one with pedicel, knob or apophyses, and terminal lance; wall trilaminate, with well developed middle prismatic layer; eupelagic, marine. Type species *Xystonella treforti* (Daday) Laackmann from off Naples.

Proposed by Brandt (1907) both as a genus and subgenus in a vacillating and indeterminate manner. Laackmann (1909) definitely disassociated Xystonella from Cyttarocylis with which Brandt had allied it. Jörgensen (1924) accepted this autonomy and allied it to Undella, Favella, and Porœcus. We (1929) removed from it to Xystonellopsis the following species: — *armata, cymatica, dahli, dicymatica, dilatata, favata, gaussi, hastata, heros, krämeri, ornata, paradoxa, pulchra, scyphium, spicata, tenuirostris,* and *torta,* leaving in Xystonella only 9 species.

Resembles Xystonellopsis and the longer species of Parundella in general form and proportions, but differs from both in having a channeled oral rim, instead of a sharp edge. The elongate conical loricæ of this genus suggest those of the Rhabdonellidæ, but lack the longitudinal ribs of that family, though having the channeled oral rim of Rhabdonella and Rhabdonellopsis. It has the same type of secondary prismatic wall structure as Parafavella but differs from it in the absence of circumoral teeth, except in *X. scandens,* and in more highly developed aboral structure. It is the simplest genus in the Xystonellidae. Includes 9 species, of which 6 are present in Expedition material. Of the 9 only *minuscula* was new and was present in Expedition

material. Subdivided into 3 subgenera, all new, viz., Proxystonella, Xystonella, and Spiroxystonella.

PROXYSTONELLA subgen. nov.

Xystonella with simple aboral horn; no pedicel, knob, skirt, or lance; wall of bowl without spiral shelf. Type species *Xystonella* (*Proxystonella*) *lanceolata* (Bdt.) Bdt. from Sta. 187 of the "Thor" off the Gulf of Taranto in the Mediterranean as figured by Jörgensen (1924, fig. 41a). Contains *acus, lanceolata, longicauda* and *lohmanni.*

XYSTONELLA subgen. nov.

Xystonella with differentiated pedicel and enlarged aboral structure, merely a clavate body in *clavata,* but a knob, skirt, and lance in *treforti* and *minuscula;* no spiral shelf. Type species that of genus, *Xystonella treforti* (Daday) Laack. from Gulf of Naples. Includes *clavata, treforti,* and *minuscula.*

SPIROXYSTONELLA subgen. nov.

Xystonella with pedicel, knob, skirt, and lance; wall of bowl with a spiral shelf of many turns. Type species is the only one in the subgenus, *Xystonella* (*Spiroxystonella*) *scandens* (Bdt.) Bdt. from Sta. "Dahl, 18–II–'97" off Ralum in Western Tropical Pacific. This type of spiral evolution occurs elsewhere in the Tintinnoinea only in *Climacocylis* (*Coxiellidæ*). Spiral structure is entirely absent elsewhere in Xystonella, but appears in spiral ridges on pedicels of several species in Xystonellopsis. It hardly seems to indicate any close relationship to Climacocylis, but illustrates the random emergence of comparable characters in widely divergent families.

Xystonella acus (Brandt) Brandt

Lorica tall, conical, chalice-shaped, flaring orally, aboral horn not differentiated into pedicel and lance; 4.8 o.d. (3.56–5.47 in Brandt's figures) measured at opening. Oral margin in section a rounded angle of 40°. Oral rim 0.03 o.d. in height, slightly higher than outer lip. Circumoral trough angled (100°), deepest near oral rim. Lip everted, angled (50–70°) in section. Suboral flare abrupt, restricted within to 0.11 o.d. below oral margin, or diffused over 0.5 o.d. Circumoral region

0.07–0.09 o.d. in width, with diameter to margin of lip 1.15–1.19 o.d. Bowl 0.60 (in Brandt's figures 0.67–0.85) t.l., with minor irregularities in outline, with slight distal convexity above lower cone. Suboral region an inverted cone of 20–55°, depending on abruptness of flare. Upper bowl 0.60–0.75 length of bowl, an inverted convex cone (10° anteriorly, increasing to 20° posteriorly), passing gradually into lower bowl, a convex cone of 30–40°, contracting abruptly into aboral horn. Aboral horn subcylindrical to conical (7–15°), tapering to 0.5 of its initial diameter near tip, thence rapidly contracting to sharp point, with central canal, to closed (?) tip, its length and basal diameter, respectively, 0.22 and 1.67 o.d. Wall of radial hexagonal secondary prisms, uniform in size at each level, between thick inner and outer lamellæ in single layer, except for two in lip; 47, 25, and 22, respectively, across one face at suboral ring, middle, and lower end of bowl, fading out in lower horn, with a fine primary mesh filling secondary fields. Lower horn dark yellow. Two macronuclei and 2 micronuclei are reported by Jörgensen (1924).

L., total, 192; horn, 70. D., oral, 38; oral lip, 46; upper end of horn, 10 μ.

At 2 stations in Drift; at 70–72°; 2 loricæ.

Xystonella clavata Jörgensen

Plate 19, fig. 11

Most elongate and delicate of lance-tintinnids. Lorica very slender chalice-shaped, with more or less elongated pedicel; 6.0–8.9 o.d. Oral shelf subhorizontal, 0.11–0.17 o.d. in width, with diameter to edge of lip 1.22–1.34 o.d. Oral margin acute, angled (80°), slightly rounded. Oral rim low, with subvertical inner slope and concave outer, rising 0.06 o.d. above lip. Circumoral trough shallow, oblique, concave. Lip in our lorica and in Jörgensen's (1924, fig. 40) not so widely everted as in Brandt's (pl. 42, fig. 8). Suboral thickening contained within an inverted concave cone of 27–105°, 0.5–1.0 o.d. in length. Bowl very slender conical, 0.60–0.73 t.l., with upper cone (9°) 1.75–2.00 o.d. in length, contracting into lower one of 20°. Aboral horn very slender and long, 4 o.d. in Brandt's lorica (pl. 42, fig. 8) and only 2 in ours, 0.2 o.d. in diameter at base. Pedicel cylindrical, about 1–3 o.d. in length. Knob a lance-like or fusiform swelling, a cone of 17° above and inverted 20° below. Tip sharp-pointed, not elongated into lance. Wall with delicate lamellæ and middle layer composed of radial, regular hexagonal prisms smaller in anterior 0.4 than in middle of

lorica, and minute posteriorly; very thin, except in lip. Animal in our lorica had 2 irregular macronuclei in division.

L., total, 242; aboral horn, 100. D., oral, 40; lip, 50μ.

At Sta. 4701 in Drift; at 72°; 1 lorica.

Xystonella lanceolata (Brandt) Brandt

Lorica graceful, very much elongated chalice-shaped, with slender bowl, flaring lip, elongated pedicel, and terminal fusiform enlargement; 5.4–7.4 o.d. Oral margin sharp. Circumoral shelf oblique. Oral rim angled (30°) in section, raised above suboral lip 0.1 o.d., its inner face flaring in an inverted cone (45°), its outer contour contained within a cone of 75–80°. Circumoral trough shallow, wide-angled (135°) on outer oblique slope of shelf. Lip strongly protuberant, sharp-edged, in section an angle of 70°, with concave lower surface, its contour contained within a cone of 110°, and diameter to margin of lip 1.15–1.18 o.d. Suboral thickened zone extending 0.5 o.d. below rim. Bowl with upper cone (8°) continuing for 2.00–2.25 o.d., then contracting abruptly into lower cone (26–30°), 1.0 o.d. in length. Aboral horn to tip of lance 4.2 o.d. in length. Pedicel cylindrical, 1.5–3.0 o.d. in length, enlarging distally into a lance-shaped or fusiform terminal knob, whose length and diameter are, respectively, 0.55 and 0.29 o.d. Tip acute, closed. Knob contains enlarged typical prisms.

L., total, 258; aboral horn, 150. D., oral, 38; lip, 45; pedicel, 7; knob, 11μ.

Hensen (1911) uses the name *Undella lanceolatus* (*nomen nudum*) in a table of occurrences from the Atlantic South Equatorial. Since the specific name *lanceolata* was used by Brandt in the Tintinnoinea only in Xystonella, the inference is that Hensen's reference is to this species of Brandt's. The context, however, of Hensen's table is not in agreement with the data of Brandt's table (1907, p. 258), so this allocation may be regarded as tentative.

At Sta. 4695 in Easter Island Eddy; at 74°; 1 lorica.

Xystonella longicauda (Brandt) Brandt emended Kofoid and Campbell

Plate 19, figs. 1, 9

One of the most elongate of the lance-tintinnids, lorica attenuate chalice-shaped; 5.14–6.40 (5.72) o.d. in length. Oral region more highly differentiated than in other species, though exceedingly variable.

In highest development with a rounded and entire or minutely and irregularly crenulated, sharp-edged oral margin; a flaring horizontal oral shelf, abruptly everted, 0.1 o.d. in width, and diameter at lip 1.19–1.24 o.d. Oral rim with inner face vertical or sloping (25°) obliquely inward and outer 15–30° outward, with height 0.75 width of shelf, rising a little above level of lip. Circumoral trough angular (105°) or almost semicircular in section; in loricæ with less developed oral region only a shallow groove, 0.5 width of shelf in depth, indented in the squarely truncate oral end. Bowl tapering suborally for 1 o.d., an inverted segment of a concave cone (30°); for 1.30–1.75 o.d. below this, cone decreasing to 12°, then increasing to 22–26° for 1.0–1.5 o.d., and passing gradually into aboral horn. In a few loricæ some contraction in suboral region. Aboral horn very slender, tapering, not over 0.3 o.d. in diameter at base, 0.41–0.52 (0.46) t.l., 2.38–3.23 (2.65) o.d. in length, terminating distally in a sharp closed point, with no knob, or with slight trace of an expansion. Wall composed of a single layer of radially located, regular hexagonal prisms enclosed between thin, faintly double-contoured outer and inner lamellæ, except in lip and thickened suboral region, where there are 2–4 for 1 o.d. below rim; thinning gradually from suboral zone to aboral horn formed only of the two lamellæ. Prisms vary in number and dimension at different levels and in different loricæ at corresponding levels, as a rule smaller in suboral ring, largest in upper half of bowl, decreasing aborally, and smallest in upper end of horn. In one lorica there are, respectively, 75, 38, 47, and 15 across one face in suboral ring, upper bowl, lower bowl, and upper horn. Two oval macronuclei, 6 by 12 μ.

Ten loricæ: L., total, 190–256 (234.0); aboral horn, 88–118 (108.3). D., oral, 37–44 (40.9); lip, 46–56 (53.4) μ.

At 8 stations, viz., at 2, 1, and 5, respectively, in California Current, Easter Island Eddy, and Drift; at 68–75 (72.3)°; 20 loricæ.

Xystonella minuscula Kofoid and Campbell

Plate 19, fig. 8; Plate 20, figs. 1–5

Lorica elongated, flaring subconical chalice-shaped; 4.43–6.49 (5.61) o.d. or 3.67–4.69 (4.24) diameters of oral lip. Oral margin entire, sharp. Oral shelf flat, wide, 0.18 o.d. in width, diameter to lip 1.34 o.d. Suboral thickened region abruptly flaring, often asymmetrically, 0.3–0.6 o.d. in length. Oral rim vertical on inner face, sloping (35°) on outer, triangular in section, not rising above lip. Circumoral trough broad, shallow, and nearly symmetrical. Lip widely flaring, with

thin, minutely and regularly serrated edge, with 50 points on one side, concave below, contained in an inverted cone of 25–55°. Bowl forming 0.51–0.64 (0.57) t.l., divided below suboral flare into two subconical regions, the upper an inverted cone up to 7°, not over 1.5 o.d. in length, with gradual transition into lower, a slightly convex cone of 25–30°, 1.25 o.d. in length, with a more abrupt transition into pedicel. Aboral horn 2.75–3.25 o.d. in length. Pedicel concave conical (7–15°), 1.13–2.29 (1.85) o.d. in length, its least diameter above knob 0.09–0.13 o.d., with diameter at upper end 0.25–0.30 o.d., sometimes sinuous in narrowest region, expanding (30°) distally. Knob 0.14–0.24 (0.19) o.d. in diameter, squarely or obliquely truncate aborally, with 4 or 8, sometimes 3, 5, or more, salient angles on margin of skirt, sometimes merely rounded. Lance 0.22–0.68 (0.48) o.d. in length, very slender, attenuate conical to almost cylindrical, 0.03 o.d. in diameter in most of length, flaring basally to 0.2–0.4 diameter of knob. Tip closed, blunt, or squarely truncate. Wall similar to that of *X. treforti*, except that prisms are somewhat more regular and smaller, about 30–40 across upper end of bowl instead of 25–30, giving a slightly denser appearance to lorica as a whole. In the lorica figured (Plate 19, fig. 8) there is an abrupt change in the suboral zone to 80 minute prisms across one face and a comparable change midway on lower bowl. Animal with 2 oval macronuclei 10 by 20μ, two large spheroidal micronuclei, and 16 membranelles.

Ten loricæ: L., total, 268–350 (321.3); bowl, 178–208 (184.0); pedicel, 68–127 (109.1); lance, 18–42 (28.2). D., oral, 54–68 (59.0); lip, 73–80 (75.7); midway, 18–40 (27.9); knob, 10–14 (11.5)μ.

At 28 stations, viz., at 14, 3, 1, 4, and 6, respectively, in Peruvian Current, Panamic Area, Easter Island, and Galapagos eddies, and Drift; at 66–80 (70.3)°; 249 loricæ.

Xystonella treforti (Daday) Laackmann

Plate 19, figs. 2–5, 7

Cyttarocylis treforti, Gräf, 1909, pp. 152, 158, 166, 170, 175, 177, figs. [8]a, [11]a, [15]b, [17]e, [19]h, [20]a.

Hystonella treforti, Hofker, 1931b, p. 381. *Lapsus pennæ.*

Lorica very elongated, large-bowled, chalice shaped; 6.50–7.78 (7.10) o.d. Circumoral shelf horizontal, flat, narrow (0.05–0.09 o.d. in width), with diameter to lip 1.11–1.19 o.d. Oral margin entire, sharp. Oral rim very low, lower than lip, with inner face vertical and sloping up to 20° from vertical on outer, triangular in section. Circumoral

trough slightly concave or angular (115°) in section, deepest near rim. Suboral thickening fading out within 0.2–0.5 o.d. below lip. Lip usually not strongly everted, with an acute or blunt edge, its lower contour concave, contained within an inverted cone of 25–35°, rarely 55°. Margin of lip smooth, crenulate, or serrate with minute to stout triangular erect teeth, 25–60 across one side. Bowl 0.56–0.74 (0.64) t.l., with subconical (up to 7°) upper cone 2.5–3.0 o.d. in length, passing into convex lower cone (25–35°) 0.5–1.0 o.d. in length. Both upper and lower transitions gradual. Pedicel conical (9–12°), 1.32–2.52 (1.93) o.d. in length, with upper and lower diameters, respectively, of 0.25–0.33 and 0.10–0.07 o.d., expanding rather abruptly into knob in a pyramid of 40°. Knob with diameter of 0.09–0.29 (0.19) o.d., spreading laterally into a squarish or angular skirt, whose angles project aborally in salient points, in a quadrangular and squarely truncate form, though irregular, circular, oblique, or asymmetrical in some loricæ. Lance continuing from its aboral center, 0.46–0.77 (0.59) o.d. in length, a slender cone (up to 10°) or cylinder, with basal diameter 0.25–0.33 that of knob, with a blunt closed tip and thick walls, with central canal sometimes extending but a short distance into its base. Wall exceptionally thick, very transparent, brownish in pedicel, with larger prisms 25–30 across upper part of bowl, much smaller in suboral zone and pedicel. Animal filling 0.5–0.6 of lorica, with 16 membranelles, 2 (4) large oval macronuclei, each 8 by 20μ, and 2 small spheroidal (8μ) micronuclei adjacent to macronuclei, attached deeply in pedicel. In two individuals a lateral peristome of the lower daughter of one dividing animal was visible, one of which had a single macronucleus 8 by 25μ, and the other 5, each 10 by 12μ, grouped in a slight spiral line, with one near each end of animal.

Ten loricæ: L., total, 373–446 (406.7); bowl, 240–290 (261.4); pedicel, 76–133 (110.8); lance, 27–45 (34.1). D., lip, 70–80 (73.5); oral, 54–62 (57.3); midway, 44–62 (47.8); knob, 6–13 (11.0)μ.

At 63 stations, viz., at 4, 3, 9, 3, 8, 5, 3, and 28, respectively, in California, Mexican, Peruvian, and South Equatorial currents, Panamic Area, Easter Island and Galapagos eddies, and Drift; at 67–82 (75)°; 404 loricæ.

26. XYSTONELLOPSIS Jörgensen

Xystonellidæ with an elongated, awl- or chalice-shaped lorica; oral margin thinned, sharp, entire, or dentate; suboral region with or without thickened zone; with band, 1 to 3 rings, or fenestrated zone; bowl

elongated, with upper and lower cones distinct, except in *laticincta;* distinct pedicel present, except in simpler species of Protoxystonellopsis; skirt, or skirt and knob present, except in Protoxystonellopsis and Euxystonellopsis; aboral end terminating in a short lance; longitudinal structures, often spiraled, restricted to striæ on lower end of pedicel and to mullions of Euxystonellopsis. Wall trilaminate, with the inner and outer lamellæ feebly double-contoured, intermediate zone usually with one to several layers of prismatic alveoli; eupelagic, marine, in warm temperate and tropical seas. Type species was designated as *Xystonellopsis paradoxa* (Cleve) Jörg. by Kofoid and Campbell, 1929, p. 238.

Established by Jörgensen (1924), who segregated it from Brandt's (1906, 1907) Cyttarocylis (Xystonella) complex and from Undella on basis of thin circumoral lip and shape of bowl. He included *Xystonellopsis scyphium* Jörg.; *Xps. cymatica* (which was *Cyttarocylis* [*Xystonella*] *cymatica* Bdt. [1906]) and its variety *spicata* (= *Xps. spicata* [Bdt.] K. and C.); *Xps. paradoxa* (Cleve) Jörg. originally described as an Undella by Cleve (1900d) and called *Cyttarocylis* ? (*Xystonella*) *paradoxa* by Brandt (1907); and *Xps. brandti* (Laack.) Jörg., originally called *Undella heros* var. *c* by Brandt (1906, 1907); *Undella tenuirostris* var. *brandti* by Laackmann (1909); and *Xps. favata* called *Cyttarocylis* ? (*Xystonella*) *favata* by Brandt (1907). We (1929) accepted Jörgensen's concept of the genus, included all his species, transferred the following from Undella (Xystonella) of Brandt (1907): *Xps. armata* (Bdt.), *Xps. dahli* (Bdt.), *Xps. heros* (Cleve), *Xps. krämeri* (Bdt.) called *heros* var. *a krämeri* by Brandt, and *Xps. tenuirostris* (Bdt.); also transferred to Xystonellopsis from Brandt's (1906, 1907) Cyttarocylis (Xystonella) the following species: *Xps. dicymatica* (Bdt.), *Xps. dilatata* (Bdt.), *Xps. hastata* (Bied.) described as *Tintinnus hastata* by Biedermann (1893), *Xps. ornata* (Bdt.), *Xps. pulchra* (Kofoid) described by Kofoid (1905) as *Cyttarocylis pulchra,* and *Xps. torta* (Kofoid) described by Kofoid (1905) but reduced by Brandt (1907) to a variety of *Cyttarocylis pulchra;* and also transferred from Undella, Laackmann's (1909) *Undella heros* var. *gaussi* as *Xps. gaussi;* and added 13 new species, 12 from Expedition collections and one, *Xps. mascarensis,* segregated from Laackmann's (1909) *Xystonella dicymatica.* Three new species are added in this Report, viz., *parva, tropica,* and *turgida.* The *Xps. scyphus* of Kofoid and Campbell (1929, pp. 246, 374) is a *lapsus* for *Xps. scyphium* Jörgensen correctly cited on page 250, fig. 478, of our *Conspectus.*

Apparently an offshoot of Parundella. The subgenus Parundellopsis

which is near *Parundella aculeata*, and Protoxystonellopsis even more so, through its simplest species, *Xps. pinnata*, afford transitions between the two genera. *Xps. pinnata* has minute prismatic structure, scarcely differentiated pedicel and lance, diffuse suboral thickening, and thin oral margin forming a lorica scarcely distinguishable from elongate loricæ of Parundella such as *P. longa* and *P. humerosa*.

The circumoral rim with its sigmoid outer slope and suboral ring are not unlike those of genera Amplectellopsis, Cricundella, and Undellopsis of the Undellidæ, though the aboral differentiation in these genera is wholly different from that of the Xystonellidæ. In its aboral structure Xystonellopsis parallels Rhabdonellopsis of the Rhabdonellidæ. It also shares the chalice-shaped lorica, but differs in having a sharp instead of a flat channeled circumoral margin and less development of the linear structures. Xystonellopsis represents in the Xystonellidæ the apex of evolution in the family, as Rhabdonellopsis does in the Rhabdonellidæ. It differs from Parundella in suboral development and pedicel, and from Xystonella in the circumoral margin.

Xystonellopsis resembles Parafavella in its general chalice-shaped lorica, but has more elaboration of pedicel. It differs in development of skirt and knob, both wholly lacking in Parafavella. Circumoral teeth occur only in *hastata*, but are of general occurrence in Parafavella. Wall structure is strikingly similar in the two genera.

Contains 34 species, of which 31 are in Expedition collections. Of the 34, 16 are new, 13 of which were described in our *Conspectus* (1929) and 3 in this Report, 15 of the 16 occurring in Expedition collections.

Xystonellopsis contains eight subgenera. Because of the spread of characters and their complex permutations among the species it has seemed best for the present not to break the genus up into eight genera corresponding to these groups, among which the species known at present might be distributed, but rather to await later additions in order to determine more fully the content of these subdivisions and their interrelations, and to designate them now only as eight subgenera.

PROTOXYSTONELLOPSIS subgen. nov.

Loricæ small and narrow, ranging from 154 to 248μ in length, and from 26 to 33, rarely 38μ, in o.d., stout awl-shaped; oral margin entire; oral rim feebly differentiated; suboral thickening diffuse, ranging from a low ring to a scarcely differentiated band 0.75 o.d. in length; bowl distinctly separable into upper and lower parts; pedicel either very stout and long or rather slender; no skirt or knob; lance slender, thick-

walled, with or without several alate fins. Rather close to Parundella, some of whose species have similar proportions, but have a thin-walled lance. Includes *pinnata*, *parva* sp. nov., *brandti*, *heroica*, and *constricta*. Type species *Xystonellopsis* (*Protoxystonellopsis*) *brandti* from Mascarene Current.

PROXYSTONELLOPSIS subgen. nov.

Lorica of medium size, 185–364μ, rarely smaller (120μ), as in *scyphium*, tall chalice-shaped, with bowl, pedicel, skirt, and lance clearly differentiated; oral margin entire or toothed; oral rim narrow, slightly developed; suboral thickened zone always present but not highly differentiated, ranging from a wide zone (0.5 o.d.) not strongly delimited aborally (*favata*) to a narrow, well defined suboral ring (*crassispinosa*); lower section of the bowl short and sharply set off from pedicel by abrupt change in slope; pedicel 1.0–1.6 o.d. in length, stout, with short striæ; skirt slightly flared in a feebly developed knob; wall not heavily thickened in lower pedicel and skirt. Includes *crassispinosa*, *cyclas*, *cymatica*, *favata*, *hastata*, *mascarensis*, *scyphium*, *spicata*, and *tenuirostris*. Type species *Xystonellopsis* (*Proxystonellopsis*) *cyclas* K. and C. from Atlantic North Equatorial Current.

PARAXYSTONELLOPSIS subgen. nov.

Lorica elongated, slender, and large, 354–618μ in length; oral margin entire; suboral region wholly undifferentiated; bowl slender, narrowly conical, contracting below middle (except in *heros*) into wider-angled lower cone, passing into conical or cylindrical pedicel 1–2 o.d. in length; pedicel terminating in truncate skirt without flaring into a knob; lance conical; spiral striæ on pedicel. Includes *dilatata*, *acuminata*, *armata*, *gaussi*, *dahli*, *heros*, *tropica* sp. nov., and *krämeri*. Type species *Xystonellopsis* (*Paraxystonellopsis*) *acuminata* K. and C. (1929, p. 239, fig. 482) from Sta. 4583 in California Current.

XYSTONELLOIDES subgen. nov.

Lorica large, 246–466μ in length, full-bowled chalice-shaped; bowl usually forming about half the length; oral rim and suboral thickened zone well developed, the latter much thickened, with 2–4 more or less distinct and variable suboral rings; bowl sharply set off from pedicel;

pedicel long, subconical, or cylindrical; knob and skirt highly developed; short striæ present; lance slender; wall of lower pedicel thickened. Includes *abbreviata, dicymatica, inæqualis, laticincta, pulchra,* and *torta.* Type species *Xystonellopsis* (*Xystonelloides*) *pulchra* (Kofoid) K. and C., from California Current off San Diego.

Xystonelloides has both ends of the lorica highly differentiated and to comparable degrees. Except for a fenestrate suboral band in Euxystonellopsis, the highest evolutionary development of the suboral thickened zone occurs in this subgenus. This is true both of the total mass of lorica-forming material and of the specialized structures formed from it. The principle of metamerism, or repetition of parts, reaches its maximum expression in the Tintinnoinea in this subgenus. It is exhibited in the repetition of suboral bands from 1 to 4, with indications of even a fifth in *torta;* in repetition of skirts in *laticincta,* and in reduplication of pedicel in *laticincta* and *pulchra.*

MACROXYSTONELLOPSIS subgen. nov.

Lorica very large, 323–388μ; greatly elongated, very tall chalice-shaped; with upper bowl, lower bowl, pedicel, knob, and lance clearly differentiated; oral margin entire; oral rim developed; suboral thickening present as a slightly diffuse ring; pedicel very long, duplicated in smaller diameter; no striæ; knob quadrangular, duplicated below in smaller size; lance slender; wall greatly thickened in knob. Type and only species is *Xystonellopsis* (*Macroxystonellopsis*) *clevei* K. and C. in the Easter Island Eddy.

Macroxystonellopsis is unique among the subgenera in reduplication of pedicel, but shares with Xystonellopsis reduplication of knob. Its suboral differentiation remains at the low level of specialization attained in Proxystonellopsis and Protoxystonellopsis. Reduplication of pedicel is foreshadowed in the constriction of the pedicel above the skirt in *Xps.* (*Proxystonellopsis*) *cyclas* and in *Xps.* (*Xystonelloides*) *laticincta.*

XYSTONELLOPSIS subgen. nov.

Lorica of medium length, 182–229μ, stout, conical vase-shaped; oral margin entire; oral rim present; suboral thickened zone wide, not distinctly annulate, not delimited posteriorly; bowl feebly differentiated into upper and lower sections, distinctly conical; pedicel barely differentiated, striate; knob and skirt unusually wide, duplicated, secondary

knob smaller than primary; lance rather stout; wall structure delicate. Includes *conicacauda* and *paradoxa* (Clere) Jörgensen. The latter, from the Florida Current of the Atlantic, is the type species alike of genus and subgenus.

The subgenus Xystonellopsis occupies a somewhat isolated position in the genus because its aboral region is both enlarged and highly differentiated, while its suboral region remains in a very primitive condition. It has an aboral enlargement comparable in volume to that in Euxystonellopsis, but its pedicel, skirt, knob, and lance are all differentiated and the skirt and knob are duplicated. In the last characteristic, Xystonellopsis is paralleled by Macroxystonellopsis, which duplicates the pedicel also. Its suboral zone remains in an undifferentiated state comparable to that in Proxystonellopsis. In the delicacy of the structure of its wall, it approaches but does not attain that in Euxystonellopsis.

EUXYSTONELLOPSIS subgen. nov.

Lorica moderately large, 200–269μ, stout, subconical (10°), vase-shaped, with distinct oral rim, suboral band, and bowl, but lower bowl, pedicel, knob, and lance more or less submerged in a massive aboral thickening; oral margin entire; oral rim thin; suboral band wide, with upper and lower rings and vertical or spiral bars separating thinner-walled fenestræ; bowl not divisible into upper and lower sections; massive aboral thickening representing the knob with trace of spiral moulding; no differentiated pedicel; lance stout; wall exceedingly delicate and translucent. Includes only *Xystonellopsis* (*Euxystonellopsis*) *ornata* (Brandt), the type from Atlantic North Equatorial Current.

PARUNDELLOPSIS subgen. nov.

Lorica short goblet-shaped, 125–177μ in length; suboral region not thickened; bowl moderately tall, rather slender, slightly tapering goblet-shaped, the subcylindrical upper section merging gradually into the convex inverted conical lower one; pedicel distinct, short; knob slightly developed; skirt distinct; short striæ present (in *epigrus*); lance slender; wall not thickened in pedicel. Includes *epigrus* and *turgida* sp. nov. Type species *Xystonellopsis* (*Parundellopsis*) *epigrus* K. and C. from Sta. 4734 in the Drift.

Parundellopsis has an undifferentiated suboral region and stout lorica, as in the simpler species of Parundella, but in addition has the pedicel, skirt, and lance characteristic of Xystonellopsis. It differs from other subgenera, except Paraxystonellopsis, in absence of suboral thickening, and from that subgenus in short instead of elongated bowl. The globose pedicel in *turgida* is suggestive of the aboral contour in *Parundella clavus* and *P. aculeata*.

Xystonellopsis abbreviata Kofoid and Campbell

Plate 22, figs. 3, 4, 9

Lorica small, triple-ringed, chalice-shaped, with bowl and pedicel subequal, slightly spreading skirt, and long, slender lance; 4.88–5.63 (5.28) o.d. Bowl, pedicel, and lance, respectively, 2.68, 2.00, and 0.50 o.d. in length. Oral margin thin, rounded. Oral rim usually flaring (up to 10°), with concave outer and convex inner slope, 0.20–0.25 o.d. in length. Suboral thickened zone with 3 rings, 1.02–1.44 (1.24) o.d. in length, including somewhat less than upper half of upper bowl; its wall thickened in three subequidistant rings, lowermost usually largest, separation between uppermost and middle less deep than between middle and lowermost. In some loricæ 3 rings equally developed, in others (Plate 22, fig. 9) uppermost smallest and rather thin, in still others middle one almost suppressed, or merged in a general thickening of that region. No fourth ring has been found in this species, though suggestions of it appear in one lorica. Greatest diameter on rings 1.24–1.37 (1.33) o.d. Bowl 0.5 t.l., with upper bowl subcylindrical, sometimes a trifle constricted below suboral ring, 1.9–2.1 o.d. in length; lower bowl contracting rapidly in an inverted cone of 25–35°, 0.75–1.10 o.d. in length. Transition into pedicel gradual with some concavity. Pedicel elongate, changing from an inverted cone of up to 16° above to subcylindrical below, with slight constriction above skirt, its length and diameter 1.82–2.26 (2.03) and 0.20–0.26 (0.23) o.d., respectively. Skirt flaring below constriction to diameter of lower part of pedicel; rounded or angular, with or without 8 short, leiotropic ridges, extending only to or across constriction. Lance slender, slightly tapering (5°), with or without basal flare, with occluded central canal, and rounded, closed tip, 0.44–0.85 (0.58) o.d. in length. Wall with same structure as in *pulchra*, its inner and outer lamellæ more sharply defined in aboral region than orally. Prisms largest in lower part of suboral band and in two lower rings, 3–6 layers in suboral band and rings, 1, 3, and 1 in bowl, pedicel, and lance, respectively, fading out on base

of lance. Animal with 2 round macronuclei, each 15 μ in diameter, and 14 membranelles.

Eight loricæ: L., total, 275–336 (295.1); suboral zone, 37–58 (45); pedicel, 100–136 (113.2); lance, 25–45 (32.2). D., oral, 51–60 (55.9); greatest diameter of rings, 70–82 (74.1); pedicel, 11–15 (13.1); skirt, 10–16 (13.2) μ.

At 3 stations in California Current; at 69–83 (74.3)°; 10 loricæ.

Xystonellopsis acuminata Kofoid and Campbell

Plate 21, fig. 13

Lorica stout awl-shaped, its lower half distinctly conical (15°), with bowl merging with pedicel, and skirt weakly developed; 5.62–6.00 (5.81) o.d., divisible into bowl, pedicel, skirt, and lance. Oral margin rounded. Oral rim not specialized beyond a slight flare due to thinning of convex inner slope. Bowl 0.65 t.l., with upper and lower cones not clearly delimited from each other; upper part convex subconical (0–4°), less than 0.5 t.l. in length; lower slightly concave conical (13–15°). Pedicel not differentiated from bowl by slope but by 8 low, dexiotropic surface lists, passing orally for 1.5 o.d. with not more than 100° revolution. Skirt without flare, recess, or angles, squarely truncate, 0.13–0.16 (0.15) o.d. in diameter. Vertical lists present on one lorica, and another with a slight skirt had scarcely any lists. Lance slender, conical (10–18°), 0.34–0.55 (0.41) o.d. in length, with basal diameter 0.2–0.4 its length, with narrow central canal. Wall of heavy inner and outer lamellæ enclosing small, regular secondary polyhedral prisms, increasing in size in aboral region. Wall of bowl uniform in thickness, of several layers of prisms in upper bowl, a single layer in lower cone, thickening distally in skirt, with layers increasing to five. Prisms across one face are 150, 100, 26, and 34 at successive levels from oral to aboral end.

Four loricæ: L., total, 354–414 (383.2); to skirt, 320–382 (354.5); lance, 23–34 (28.8). D., oral, 63–69 (66.0); skirt, 9–11 (10) μ.

At 3 stations, viz., at 2 and 1, respectively, in California and Mexican currents; at 76–83 (80.3)°; 3 loricæ.

Xystonellopsis armata (Brandt) Kofoid and Campbell

Xystonella armata, Reichenow, 1927, p. 65, figs. 81, 4, 4a.

The most striking features of this lorica are its very slender bowl and very stout pedicel; distinctly divided into bowl, pedicel, and lance;

6.1–8.1 (7.0) o.d. Oral margin rounded. Oral rim suggested by slight external thinning of wall. No localized suboral thickening; wall thickest short distance below rim. Bowl 0.56–0.61 (0.59) t.l., 3.7–4.8 (4.1) o.d. in length, with distinct shoulder between upper and lower cones; the upper subconical (up to 5°), 0.75 length of bowl; the lower convex conical (15–23°) 1.0–1.5 o.d. in length. Transition into aboral horn abrupt, at a level a little below middle of lorica. Pedicel narrowly conical (4°), flaring distally, with length and diameter 2.0–2.8 (2.4) and 0.29–0.40 (0.33) o.d., respectively. Skirt truncate, recessed, with short conical (up to 30°) expansion with 6–8 surface longitudinal lists passing upwards from skirt for 0.4–0.8 of length of pedicel, generally vertical, or with a slight spiral twist, leiotropic, except in two of Brandt's figures (pl. 43, figs. 6, 7) with a dexiotropic spiral. Lists formed by projecting ridges of prismatic substance of wall, giving to pedicel a more cylindrical outline by masking its slight taper and feeble flare of skirt. Lower ends of lists form salient points at edge of skirt. Lance short, very stout, conical (34–40°), 0.34–0.62 (0.47) o.d. in length, with basal diameter 0.50–0.65 that of end of pedicel, and 0.45–0.80 its height, with tapering central canal to tip. Wall made up of minute, supposedly secondary prisms, forming hexagonal fields on surface, with usual sequence of dimensions reversed; instead of increasing in diameter orally, they become largest aborally; 3 layers in suboral region, 2 in bowl, 1 in pedicel, and 3–4 in skirt and lance; lists with 4–6 rows in radial direction; number across one face difficult to determine because of minute size, approximately 125–150, 50–60, 15, and 13 on upper end of bowl, top of pedicel, skirt, and base of lance, respectively. Laackmann (1909, pl. 48, fig. 9) found 2 elongate macronuclei, 2 oval micronuclei, and 10 membranelles on one side.

Ten loricæ: L., total, 392–456 (421.1); bowl, 230–274 (247); pedicel to lance, 132–169 (145.8); lance, 21–32 (28.3). D., oral, 60–88 (63.4); pedicel, 17–25 (20.2); skirt, 20–25 (22.5) μ.

At 13 stations, viz., at 2, 1, 5, 1, and 4, respectively, in California, Mexican and Peruvian currents, Galapagos Eddy, and Drift; at 68–83 (72.9)°; 30 loricæ.

Xystonellopsis brandti (Laackmann) Jörgensen

Plate 21, fig. 11

Lorica moderately stout, tapering chalice- or awl-shaped, with distinctions between bowl, pedicel, and lance indicated by contour changes; 6.13–6.63 (6.38) o.d. Bowl, pedicel, and lance, respectively,

3.6, 1.64, and 1.18 o.d. in length. Oral margin bluntly rounded. Oral rim 0.35 o.d. in length, thick, with vertical or slightly flaring inner face and trace of concavity on otherwise convex outer slope. Suboral thickened zone 1.07–1.33 (1.24) o.d. in length, thinning out below, widest, 1.15–1.17 o.d., about middle. Bowl 0.51–0.60 (0.56) t.l., upper bowl (omitting thickened zone) an inverted cone of up to 5°, 0.7 length of bowl, scarcely set off from contracting, more convex conical (20–24°) lower bowl. Transition to aboral horn abrupt, with a sharp change in contour. Pedicel subconical (10°), 1.23–1.84 (1.64) o.d. in length, with upper diameter 0.39–0.62 (0.51) o.d., passing with a concave contraction 0.25 o.d. in length into lance. Aboral horn 0.40–0.49 t.l., with pedicel and lance 0.6 and 0.4 its length, respectively. Lance an inverted cone of 10° or less, 0.97–1.39 (1.18) o.d. in length, continuing slope of lower pedicel, with narrow central canal beginning abruptly at upper end of constriction. Tip blunt, closed. Lists low, short, stout, spanning and masking constriction. Constriction homologous to lower surface of knob in other subgenera. Wall composed of small, regular secondary prisms, uniform in size at a given level, hexagonal, in radial positions in one layer, except in suboral zone with 2–3, and lance with 2–4; 45–50 across one face on suboral zone and 12 on upper end of lance; smaller in pedicel than upper part of bowl. Animal large, elongated, nearly filling bowl, with 16 membranelles.

Six loricæ: L., total, 184–210 (197.7); suboral zone, 32–43 (38.3); bowl, 102–125 (110.3); pedicel, 37–59 (50.7); lance, 32–43 (36.7). D., oral, 30–33 (31); suboral zone, 35–38 (36.3); constriction, 13–20 (15.7) μ.

At 12 stations, viz., at 2, 1, and 9, respectively, in Peruvian and South Equatorial currents, and Drift; at 68–81 (76.7)°; 15 loricæ.

Xystonellopsis clevei Kofoid and Campbell

Plate 20, figs. 6–8, 11, 12, 14, 15

Lorica greatly elongated with repeated pedicel and knob, very tall chalice-shaped, with bowl considerably shorter than combined pedicels, equaling larger primary pedicel in length, and very slender lance; 6.59–7.50 (7.26) o.d. Bowl, upper and lower pedicels, and lance, respectively, 2.9, 2.4, 1.3, and 0.4 o.d. in length. Oral margin broadly rounded. Oral rim vertical or little everted distally, deeply concave or obliquely angled (150°) outwardly, subvertical on inner slope, 0.16–0.24 o.d. in length. Suboral thickened zone with single distinct ring, or wide flattened ring, or single ring followed by thickened band with

incipient ring in lower part, with maximum diameter 1.10–1.31 (1.25) o.d. and length not over 0.3 o.d. Bowl 2.65–3.23 (2.92) o.d. in length and 0.75 length of pedicel measured to skirt; upper bowl an inverted cone (4°) contracting abruptly at 2.0 o.d. below oral margin into lower bowl, an inverted cone (18–20°), 1.25–1.50 o.d. in length. Pedicel region differentiated into longer, wider upper or primary cylindrical pedicel, and shorter, narrower, thicker-walled lower or secondary one; length and diameter of upper are, respectively, 2.25–2.67 (2.39) and 0.20–0.26 (0.24) o.d.; lower cylindrical above, becoming squarish towards knob, its length, measured to knob, and diameter, respectively, 1.31–1.85 (1.51) and 0.08–0.14 (0.10) o.d., flaring abruptly below. Knob a regular, four-sided, concave pyramid (40–50°) of unusual width, wider than upper section of pedicel, 0.39–0.49 (0.45) o.d. across long diagonal; duplicated, with lower end of primary knob abruptly truncate, 0.48 o.d. on one edge of skirt, smaller secondary knob, less perfect in outline, truncate distally, 0.35 o.d. on one edge, and sometimes with one or more angles interpolated between four main ones, its diameter 0.6–0.8 that of upper knob, and its length not over 0.5 its diameter. Lance very slender, subcylindrical, with or without basal expansion, and occluded central canal, 0.26–0.49 (0.41) o.d. in length, and basal diameter 0.14–0.20 its length. In two loricæ delicate, translucent fins extended from tip of lance to each of the four angles (Plate 20, figs. 13, 14). Such fins on aboral horn are unusual in the Tintinnoinea, though very frequent in the dinophysoid Dinoflagellata. Their adaptive nature as rudders or vanes is suggested by their location, though their method of formation is indeed puzzling. There is no suggestion in the structure of these loricæ of their extraneous origin. The nearest approach to such structures elsewhere are the distal prismatic vanes on the aboral horn in *Favella helgolandica* and the alate lists in the subgenus Protoxystonellopsis, but the vanes in *clevei* are thin and hyaline, not prismatic as in that subgenus. Wall (Plate 20, fig. 8) composed of regular prisms, uniform in size at a given level, the number of layers being much greater and size of prisms smaller in oral rim, suboral ring, and lower pedicel and knob than elsewhere; 8–10 layers of small prisms in suboral ring, 2–3 of larger ones in partially developed suboral band, 1 in bowl below ring, in upper pedicel, and in lance, 2–3 in lower pedicel, and 2–4 in knob; 75, 95, 32, 28, 16, 8 and 16–20 prisms across one face, respectively, on oral rim, suboral ring, upper and lower bowl, upper and lower pedicel, and knob.

Nine loricæ: L., total, 323–388 (353.6); bowl, 130–155 (142.4); upper section of pedicel, 98–130 (116.3); lower section, 64–89 (73.7); lance,

18–24 (20.1). D., oral, 47–49 (48.7); suboral diameter, 54–64 (60.8); knob, 19–24 (22.1); upper pedicel, 10–13 (11.9); lower pedicel, 4–7 (5.1) μ.

At 11 stations, viz., at 6 and 5, respectively, in Easter Island Eddy and Drift; at 72–75 (73.6)°; 32 loricæ.

Xystonellopsis conicacauda Kofoid and Campbell

Plate 19, figs. 6, 10, 12

Lorica stout, elongate subconical, tall vase-shaped; 4.66–5.15 (4.98) o.d. Bowl, pedicel, knob, and lance, respectively, 3.5, 1.0, 0.5, and 0.4 o.d. in length. Oral region slightly everted. Oral margin rounded, thin. Oral rim subvertical on both faces, concave outwardly below, 0.25 o.d. in length. Suboral zone 0.7–1.0 o.d. in length, merging gradually both above and below into wall, greatest diameter (1.15 o.d.) usually nearer anterior margin; surface slightly undulating in two major and sometimes several minor waves, a condition suggestive of incipient rings. Bowl not divisible into upper and lower cones, 0.82 t.l., or about 4.3 o.d., an inverted cone of 6–8° with straight sides, apart from suboral zone. Pedicel not sharply differentiated by surface structure, but distinguished by increase in thickness of wall; not over 1.0 o.d. in length, with upper diameter 0.66–0.75 o.d. Primary knob an irregular truncated cone of 20–45°, bearing 4–12 linear, sinuous, or left-wound spiral ridges on its surface, flaring (20–75°) into upper recessed skirt, 1.0 o.d. in diameter. Knob duplicated, upper massive, with a heavy ledge-like skirt; lower one with scarcely projecting lower skirt, inverted subconical (22°), becoming subcylindrical below, with recessed but not flaring skirt. Diameters of upper and lower 0.90–0.98 (0.92) and 0.55–0.60 (0.57) o.d., respectively, and distance between 0.36–0.60 (0.46) o.d. Surface of lower knob often with slight central bulge and constriction below it suggestive of an incipient tertiary knob; one lorica with traces of superficial ridges on area between skirts. Lance low, massive, a perfect cone (55°), 0.38 o.d. in length, with basal diameter a little less than, or equal to, its height, very thin-walled except (Plate 19, fig. 12) at its base, where its lumen joins the wide cavity of pedicel. Tip acute, closed. Wall composed of small primary prisms, no smaller ones having been seen by us within them; 1–2 layers in oral rim, 3–4 in suboral zone, 2 in conical shaft, 8–9 in upper knob, 5 in lower knob, and none in the very thin wall of the lance, it being formed by opposed inner and outer lamellæ; 70 on one face across suboral zone, growing smaller by about 30% in oral rim above, somewhat smaller on conical shaft, larger in

lower part of pedicel, and smaller in lower knob. Wall thickest in suboral zone and pedicel, thinnest in cone.

Six loricæ: L., total, 188–229 (204.3); to skirt, 155–174 (167.6); between rings, 16–24 (19.0); lance, 14–16 (15.6). D., oral, 40–42 (41.0); suboral ring, 46–47 (46.8); upper skirt, 36–39 (37.8); lower skirt, 22–24 (23.4) μ.

At 13 stations, viz., at 3 and 10, respectively, in Easter Island Eddy and Drift; at 68–81 (74.1)°; 15 loricæ.

Xystonellopsis constricta Kofoid and Campbell

Plate 21, figs. 3, 4, 6, 7, 10, 15

Lorica exceedingly elongate, very thin-walled, subcylindrical, with long bowl, very long pedicel, and short conical lance; 7.18–9.07 (7.90) o.d. Bowl, pedicel, and lance 3.88, 2.87, and 1.50 o.d. in length, respectively. Oral margin sharp. Oral rim thin, with outer sloping or concave face and inner flaring one, 0.18–0.30 o.d. in length. Suboral thickened zone relatively thin, 0.09–0.16 o.d., merging gradually into wall below, within 1.0 o.d. of rim. Greatest diameter of suboral zone 1.07–1.23 (1.11) o.d., located at upper margin. In loricæ with thin suboral region localized suboral ring (in extreme form in Plate 21, fig. 5) 0.2 o.d. below rim. Bowl 0.5 t.l., or 3.61–4.52 (3.88) o.d. in length, with subcylindrical (3–5°) upper part, 2.75–3.25 o.d. in length, and inverted conical (17–25°) lower one, 0.33 length of upper, contracting for 1.0–1.5 o.d. to pedicel. Aboral horn 0.50–0.63 t.l. Pedicel set off above by change in slope and below by deep constriction, subcylindrical, with slight concavity above, gentle expansion in lower third, rounding distally in convex cone (35°) into deep constriction; its length and diameter 2.13–3.27 (2.86) and 0.55–0.69 (0.58) o.d., respectively. Zone of constriction 0.25–0.33 o.d. in length and 0.16 in least diameter. Conical contour of aboral region preserved by four vertical or slightly leiotropic prismatic lists 0.5 o.d. from upper limit of constriction to top of lance. Lance elongate, conical (8–15°), with upper end slightly swollen, 0.87–1.41 (1.16) o.d. in length; basal diameter 0.20–0.33 o.d., with slender central canal occluded distally. Tip rounded, closed. Wall uniform in thickness, except in thickened suboral ring, region of constriction, and lance; of regular secondary prisms in single row of radial polyhedrons between thin inner and outer lamellæ, except in suboral region (2–3 rows), constriction, and lance (2–5 rows); 42, 31, 24, 11, and 12 across one face on suboral zone, bowl below zone, pedicel, constriction, and upper end of lance, respectively, largest below zone, decreasing slightly

aborally, and smallest in lance. Animal small, filling less than 0.3 of lorica, with 2 spherical macronuclei 16μ in diameter, and numerous food bodies.

Five loricæ: L., total, 201–248 (224.2); bowl, 101–122 (110.2); pedicel, 68–98 (81.2); lance, 27–38 (32.8). D., oral, 26–31 (28.4); suboral zone, 30–33 (31.6); pedicel, 15–18 (16.6)μ.

At 3 stations, viz., at 1 in Easter Island Eddy and 2 in Drift; at 72–75°; 7 loricæ.

Xystonellopsis crassispinosa Kofoid and Campbell

Plate 20, fig. 13

Lorica fairly elongate, stout chalice-shaped, with long stout pedicel, wide skirt, and stout conical lance; 5.3–5.6 o.d. Upper bowl, lower bowl, pedicel, and lance, respectively, 2.00–2.25, 0.8, 2.1–2.3, and 0.39–0.55 o.d. in length. Oral margin thinned to a rounded edge. Oral rim slightly everted, 0.25 o.d. in length. Suboral thickened zone a distinct ring, expanding to 1.13–1.17 o.d. at 0.25 o.d. below rim, 0.33 o.d. in length, a round-angled flange around upper bowl. Bowl 0.5 t.l., with inverted upper cone (5–6°) 2.00–2.25 o.d. in length, lower an inverted cone of 22–25°, 0.8 o.d. in length. Transitions between upper and lower cones and lower cone and pedicel with sharp changes in contour. Pedicel very stout, distinctly cylindrical, 2.1–2.3 o.d. in length and 0.33–0.38 o.d. in diameter. Skirt flaring, with diameter 1.4 that of pedicel, and lower truncate but not angled margin, with short striæ on surface. Lance very stout, conical (19–28°), with basal diameter of 0.39–0.55 (0.50) its length, and tapering central canal. Tip acute, closed. Wall in suboral ring 0.16 o.d. in thickness, thinning gradually below to 0.05 on bowl and pedicel, thickening a short distance above knob to 0.10; of small secondary prisms between thin outer and inner lamellæ, smallest in oral rim, suboral ring, and pedicel, 85 across suboral ring and 7–8 deep, largest, 32 across one face, below suboral ring, decreasing aborally, near knob and lance again large, a single layer below ring, and 2–3 in knob and lance.

Two loricæ: L., total, 244–265; bowl, 130–135; pedicel, 96–106; lance, 18–24. D., oral, 46–47; suboral zone, 52–55; midway, 25–26; pedicel, 15–18; skirt, 18μ.

At 2 stations, 1 each in Galapagos Eddy and Drift; at 73–75°; 2 loricæ.

Xystonellopsis cyclas Kofoid and Campbell

Lorica elongate, fairly stout chalice-shaped, with long, moderately stout, cylindrical pedicel, constriction above skirt, and long slender lance; 4.86–5.74 (5.35) o.d. Upper bowl, lower bowl, pedicel and lance, respectively, 2.4, 0.7, 1.7, and 0.8 o.d. in length. Oral margin thin, rounded. Oral rim slightly everted, 0.25 o.d. in length measured from thickest part of suboral thickening. Suboral thickened zone prominent, a distinct ring generally widening to a broader, posteriorly less sharply defined band; with greatest diameter 1.10–1.21 (1.15) o.d. and length up to 0.5 o.d. Bowl 1.75–2.25 o.d. in length with gradual transition of upper into lower bowl; upper subconical (5–8°), increasing a little above middle of lorica to 25–32° in lower bowl, 0.5–1.5 o.d. in length. Pedicel stout, almost cylindrical, 1.63–2.05 (1.85) o.d. in length and 0.20–0.33 (0.29) o.d. in diameter, immediately above skirt constricting to 0.75 diameter of skirt, and swelling slightly above constriction. Skirt 1.0–1.4 diameter of pedicel with undulating margin, recessed lower surface, and 8 short striæ less than diameter of pedicel in length passing orally from edge of skirt. Lance slender conical (25°) in basal 0.25–0.33, distally cylindrical for 0.48–0.68 (0.57) o.d., basal diameter 0.16–0.30 length, with central canal almost occluded below basal cone, in most of our loricæ much more slender than in Brandt's lorica (pl. 45, fig. 1). Wall of secondary prisms between very thin double-contoured outer and inner lamellæ, smallest in oral rim, suboral ring, and pedicel, 85 across one face on suboral ring and 7–8 rows deep, largest, 32 across one face, below suboral zone, decreasing aborally to skirt and lance, enlarging there, in 1 layer below ring, increasing to 2–3 in skirt and lance. Animal with 2 tiny globular macronuclei, each 8μ in diameter.

Seven loricæ: L., total, 238–250 (243.4); oral rim to skirt, 212–224 (217.1); pedicel, 79–90 (84.1); lance, 20–31 (25.8). D., oral, 42–49 (45.5); suboral zone, 51–55 (52.1); midway, 20–28 (24.3); pedicel, 10–15 (13.3); skirt, 14–17 (15.4)μ.

At 15 stations, viz., at 2, 3, 1, 2, and 7, respectively, in Peruvian Current, Panamic Area, Galapagos and Easter Island eddies, and Drift; at 70–81 (74.7)°; 34 loricæ.

Xystonellopsis cymatica (Brandt) Jörgensen emended Kofoid and Campbell

Lorica slender, tapering chalice-shaped with long, conical pedicel, and long thin lance; 4.24–4.90 (4.60) o.d. Upper bowl, lower bowl, pedicel, and lance, respectively, 2.0, 0.8, 1.4, and 0.6 o.d. in length.

Oral margin rounded. Oral rim everted, thinning with concave outer slope, inner flaring 10°, 0.25 o.d. in length. Suboral thickened zone varying from a well defined, prominent annular ridge, sharply set off below, to a thinner, wider zone 0.6–0.8 o.d. in length and 1.08–1.18 (1.13) o.d. in maximum diameter, similar to that of *spicata*. Bowl 0.58 t.l., with upper and lower cones distinct, upper (4–6°) 2.0–2.5 o.d. in length, lower (30°) 0.6–0.8 o.d., with gradual transition near middle of lorica. Pedicel thin-walled, conical (7–9°), with length and diameter, respectively, 1.02–1.43 (1.21) and 0.20–0.25 (0.22) o.d. Skirt slight, not recessed below, scarcely flaring, without striæ above, with few or no undulations in margin. Lance evenly conical (8°), 0.52–0.76 (0.64) o.d. in length, with basal diameter 0.15–0.30 its length, with conical canal. Tip acute, closed. Wall 0.10–0.16 o.d. in thickness in suboral zone, thinning down in bowl to 0.02–0.03 in pedicel, thickening to 0.06–0.10 in skirt, and very thin in lance, consisting of very thin inner and outer lamellæ, enclosing one or more layers of fine secondary prisms, 3–5 in suboral zone, 2–1 in bowl below, 1 in pedicel, and up to 6 in skirt. Wall structureless in lance. Prisms symmetrical, very uniform at each level, largest below suboral zone, decreasing in size, both orally and aborally, to 0.5 and 0.3 of their greatest size, 45 across one face below suboral thickening. Animal quite large, with 2 irregular macronuclei.

Ten loricæ: L., total, 211–235 (221.1); bowl to skirt, 178–206 (189.7); pedicel, 50–70 (58.0); lance, 24–36 (30.8). D., oral, 45–51 (48.0); suboral zone, 51–59 (54.0); midway, 29–34 (31.7); pedicel, 9–11 (10.3); skirt, 9–13 (11.6) μ.

At 29 stations, viz., at 3, 1, 2, 4, 1, and 17, respectively, in Peruvian and South Equatorial currents, Panamic Area, Easter Island and Galapagos eddies, and Drift; at 68–87 (73.9)°; 73 loricæ.

Xystonellopsis dahli (Brandt) Kofoid and Campbell

Lorica elongated, slender awl-shaped, with divisions into bowl, pedicel, skirt, and lance feebly developed, skirt indicated only by cessation of striæ and slight change in contour; 6.53–7.29 (6.77) o.d. Lorica a cone of 9°; bowl, pedicel, and lance, respectively, 5.0, 1.0 and 0.5 o.d. Oral rim thinning abruptly without flare. Oral margin rounded. No suboral thickening. Bowl 0.75 t.l., with upper and lower cones merging gradually; upper part subcylindrical, with a little taper, 0.5 total length of bowl; lower an inverted cone of 18–22°, 1.50 o.d. in length. Transition into aboral horn abrupt. Pedicel cylindrical

or subconical, 1.0–1.5 o.d. in length, and 0.22 in diameter, sometimes deflected from vertical, with 6–8 low prismatic lists, passing orally for 1.2–1.6 o.d. in vertical or right- or left-wound spiral direction, and with not more than 160° of revolution, in slight spirals, direction often reversed within its course. Aboral termination of lists marks skirt and transition to lance. Lance conical (12–15°), 0.42–0.63 (0.53) o.d. in length, with basal diameter 0.25 its length, with tapering central canal to tip. Wall of heavy, homogeneous inner and outer lamellæ enclosing small, regular secondary prisms, larger in aboral region. Wall of bowl 0.03 o.d. in thickness, made up of 2–3 layers of prisms, with single layer in lowermost part of lower cone, rapidly thickening to 0.6 in aboral region, with up to 5 layers of prisms. Lists formed by 4–5 superposed rows. Prisms at any level quite uniform, hexagonal in surface view, and elongated in section as though under stress in aboral region; 150, 100, 30, and 32 on successive levels of bowl to its aboral end. Animal with 2 oval macronuclei, 10 by 20μ, and 2 oval micronuclei, 8 by 15μ, 1 adjacent to each macronucleus.

Ten loricæ: L., total, 396–430 (413.6); to skirt, 368–400 (381.5); lance, 28–36 (32.1). D., oral, 59–62 (60.1); skirt, 7–9 (8.1)μ.

At 12 stations, viz., at 1, 2, 1, 2, and 6, respectively, in Mexican, Peruvian and South Equatorial currents, Panamic Area, and Drift; at 66–82 (72.9)°; 23 loricæ.

Xystonellopsis dicymatica (Brandt) Kofoid and Campbell

Xps. dicymatica, K. and C., 1929, p. 245, non fig. 467; see *Xps. inæqualis*.

Lorica elongate, double-ringed chalice-shaped, with short bowl, narrow suboral band with two *equal* suboral rings, and a long pedicel; 4.9–5.4 o.d. Bowl, pedicel, and lance are, respectively, 2.8, 2.2, and 0.54 o.d. in length. Oral margin thin, sharp. Oral rim slightly everted, deeply concave outer slope and convex flaring (up to 12°) inner one, 0.20–0.22 o.d. in length. Suboral thickened zone bounded by upper and lower rings of equal diameter, 1.24–1.34 o.d. in diameter, each with a broadly rounded or acute rim. Suboral zone, measured to upper and lower edges of two rings, respectively, 0.60–0.68 o.d. in length, 0.20–0.22 in thickness on rings, and 0.10–0.12 between them, being nearly twice as thick as bowl below. Bowl shorter than pedicel and lance, giving a distinctly top-heavy appearance to lorica, forming 0.6 t.l. Upper bowl 1.7–2.0 o.d. in length, an inverted cone of 5–9°; lower 0.8–0.7 o.d. in length, an inverted cone of 35–40°. Pedicel slightly tapering, a concave, truncated, inverted cone of 12° above, decreasing to cylinder

below, and contracting from 0.35–0.45 o.d. at upper end to 0.12–0.16 at lower; 2.2–2.4 o.d. in length. Knob quadrangular, 0.22–0.26 o.d. in diameter, flaring (30°) abruptly, recessed, with four ridges passing upward from rounded angles on its edge, giving to it the form of a four-sided pyramid. Lance slender, attenuate, 0.5–0.6 o.d. in length, with basal diameter 0.2 its length, with conical canal to aciculate closed tip. Wall with well defined, double-contoured inner and outer lamellæ; enclosing symmetrical prisms uniform in size at a given level, forming in surface view regular hexagons 35–40 across one face in suboral zone, decreasing but little towards oral rim and in periphery of rings, and much more slowly aborally in bowl than in *inæqualis*, gradually reducing toward and in pedicel to half diameter in zone, increasing again slightly in knob, but not visible in lance where the two lamellæ fuse; 5–6 layers in rings, 1 in bowl, 2–4 in pedicel, and 6–8 in knob. Lower end of pedicel yellowish. Lorica delicate, easily distorted. Animal with 2 ellipsoidal macronuclei.

Three loricæ: L., total, 246–270; zone, 30–34; pedicel to lance, 110–120; horn, 25–30. D., oral, 50; upper ring, 62–67; pedicel, 6–8; skirt, 11–13μ.

In our *Conspectus* (1929) we used by oversight for this species a figure (fig. 467) which belongs to *Xps. inæqualis* instead of this species. This lorica has wide lower shelf characteristic of *inæqualis*; a better, typical figure of *dicymatica* is found in Brandt (pl. 46, fig. 1), in which the two rings are equal and closer together than in *inæqualis*.

At 6 stations, viz., at 2, 1, 1, and 2, respectively, in Mexican and South Equatorial currents, Galapagos Eddy, and Drift; at 75–84 (77.2)°; 10 loricæ.

Xystonellopsis epigrus Kofoid and Campbell

Plate 18, figs. 5, 9, 14

Lorica subconical (18°), slender goblet-shaped, with distinct bowl, knob, skirt, and lance; 2.80–2.87 o.d. Oral margin narrow, blunt. Oral rim undifferentiated, with abrupt distal flare (15°). Bowl forming 0.73 t.l., or 2.05–2.15 o.d. in length, elongate goblet- or stout bullet-shaped, with upper 0.6 convex subcylindrical and lower 0.4 convex conical (43°), passing with reversal of curvature into short stout knob, without clearly defined intervening pedicel. Knob truncate subconical (10°), 0.21–0.25 o.d. in length, and 0.25 and 0.18, respectively, in diameter at upper and lower ends; truncate distally, not recessed, bearing on its surface 8 faintly developed left-wound lists, terminating below in slight

angles on skirt. Lance a slender, thin-walled cone (7°), 0.5 o.d. in length, flaring (35°) at base, with wide central canal continued from expansion in knob. Tip sharp, closed. Wall thin, 0.025–0.040 o.d., not thickened in suboral region, uniform throughout bowl to knob, doubling in thickness in knob, becoming very thin on lance; of thin, clearly double-contoured inner and outer lamellæ enclosing single layer of minute primary prisms, 50 across one face of bowl in widest part.

Two loricæ: L., total, 123–126; bowl, 90–94; knob, 9–11; lance, 22–23. D., oral, 44; skirt, 8μ.

At 2 stations, 1 each in the Easter Island Eddy and Drift; at 75–81°; 2 loricæ.

Xystonellopsis favata (Brandt) Jörgensen

Plate 22, fig. 13

Lorica tapering, tall chalice-shaped, with short slender pedicel, slight skirt, and slender, tapering lance; 4.07–4.40 (4.22) o.d. Upper bowl, lower bowl, pedicel, and lance, respectively, 2, 1, 1, and 0.5 o.d. in length. Oral margin sharp. Oral rim thin, with concave outer and flaring (6°) inner slope, 0.15 o.d. in length. Suboral thickened zone not concentrated in ring, expanding to 1.04–1.06 o.d. at 0.23–0.33 o.d. below rim, thinning gradually within 0.50–0.75 o.d. below ring. Bowl 3.6–4.2 o.d. in length, or 0.83–0.91 t.l., with upper section inverted cone of 9–10°, and lower inverted concave one of 25–35°, with abrupt transition. Pedicel cylindrical, 1.0–1.5 o.d. in length, and 0.13–0.20 o.d. in diameter; with 3–5 short, left-wound striæ progressing orally from edge of skirt for a distance less than its diameter. In one lorica (Plate 22, fig. 13) whole pedicel with a left tortion of nearly three turns within a distance of 0.75 o.d. above skirt. Skirt without flare or recess. Lance very slender, inverted conical (10°), sharp-pointed, thin-walled, 0.47 o.d. in length, with basal diameter 0.50–0.75 that of skirt, and conical central canal below slight bulge in skirt. Wall in feebly developed suboral zone has nearly 2, and in pedicel 2–3 times, thickness elsewhere. Composed of very delicate, double-contoured inner and outer lamellæ, and an intervening layer of exceedingly fine, uniform, faint primary prisms, 2–6 layers in thickness, and 150 across one face of suboral zone. Animal in lorica from Sta. 4742, after staining in borax-carmine, showed 2 large oval macronuclei, each 10 by 18μ, 2 oval micronuclei, each 4 by 8μ, and 24 membranelles.

Ten loricæ: L., total, 228–298 (250.5); bowl, 200–272 (222.7); lance,

26–30 (27.8). D., oral, 55–64 (59.3); suboral zone, 58–67 (63.2); pedicel, 8–11 (9.4); skirt, 8–12 (9.8) μ.

Six loricæ from 69–72° measure 242–298 μ, and four from 75–81° are 228–260 μ. Long-pediceled loricæ vary toward *tenuirostris*.

At 32 stations, viz., at 2, 7, 2, 2, 1, and 18, respectively, in California, Peruvian and South Equatorial currents, Panamic Area, Easter Island Eddy, and Drift; at 66–81 (73.5)°; 72 loricæ.

Xystonellopsis gaussi (Laackmann) Kofoid and Campbell

Lorica stout, subconical; 5.62 (Laackmann's fig. 24, 6.58) o.d.; fairly well divided into bowl, pedicel, skirt, and lance. Oral margin rounded. No oral rim or suboral zone. Bowl 0.72–(0.75) t.l., 4.1–(4.7) o.d. in length, with upper slightly convex subconical (3°) region 0.66 length of bowl, and lower inverted cone (20°) 1.0 o.d. in length, merging into aboral horn. Pedicel cylindrical below, 0.6–1.0 o.d. in length and 0.18–0.27 o.d. in diameter. Skirt squarely truncate, without expansion, bearing on its surface 6–7 leiotropic, low, sometimes interrupted prismatic lists, extending from lower bowl aborally on pedicel to skirt. Lance slender conical (15°), 0.44–0.62 o.d. in length, with basal diameter 0.33 its length, with conical central canal to closed tip. Wall uniform throughout bowl, composed of equal homogeneous inner and outer lamellæ enclosing small, regular secondary prisms, 0.05–0.07 o.d. in thickness, containing several layers of prisms, doubling in thickness on pedicel.

L., total, 371; to skirt, 342; lance, 29. D., oral, 66; pedicel, 12; at skirt, 11 μ.

At Sta. 4574 in California Current; at 69°; 1 lorica.

Xystonellopsis hastata (Biedermann) Kofoid and Campbell

Plate 22, figs. 2, 7, 8

Lorica one of largest in genus, stout, widely conical chalice-shaped, with long lower bowl, short pedicel, slight skirt, and short narrow lance; 3.57–4.16 (3.99) o.d. Upper bowl, lower bowl, pedicel, and lance, respectively, 2.0, 0.4, 1.5, and 0.5 o.d. in length. Oral margin with 24–32 acute, subequal, vertical, uniform, nearly equidistant teeth with length from 0.04 to 0.08 o.d. in different loricæ. Oral rim slightly everted, with concave outer slope and locally flaring (10°) inner, 0.2 o.d. in length. Suboral zone thinning down gradually aborally, subject to local irregularities even a shallow middle trough; 0.35–0.50 o.d. in length, and 0.12–0.16 in thickness. Bowl 0.55 total length, with dis-

tinct shoulder between upper and lower parts; upper an inverted cone of 10°, 2.0 o.d. in length; lower an inverted cone of 25–30°, 1.25–1.50 o.d. in length. Transition to pedicel gradual. Pedicel short, thicker-walled, even into base of lower cone, cylindrical below, flaring slightly in knob. Length of thick-walled pedicel and skirt 0.5–0.8, rarely 1.0, and its narrowest diameter, 0.15–0.20 o.d.; surface with 6–8 leiotropic striæ 0.5–0.8 o.d. in length, passing orally from edge of skirt. Skirt flaring to 0.18–0.27 (0.22) o.d., bearing at its edge stout undulations where striæ terminate, cupped below. Lance narrow cylindrical, 0.38–0.46 (0.41) o.d. in length, basal diameter 0.50–0.68 of knob, base flaring in a short inverted cone (30°), with fine central canal continued from expansion in skirt. Wall of very heavy, equal inner and outer lamellæ, fusing in oral rim, teeth, and thin wall of lance; separated by one or more layers of secondary prisms, 1 layer in greater part of lorica, 2 in thickest part of suboral zone. At least 3 layers in pedicel and knob. Prisms minute in oral rim, largest in suboral zone, 35 across one face of zone, increasing to 70 below, rapidly diminishing in distinctness, disappearing in lower part of cone even at a magnification of 1500 diameters, growing larger again in thick wall of pedicel to size of those in lower edge of suboral zone, and wholly disappearing in lance. Animal with 2 macronuclei, only 6 by 8μ, near upper end of body on opposite sides.

Ten loricæ: L., total, 214–266 (238.3); bowl, 190–242 (213.9); lance, 22–26 (24.4). D., oral, 56–65 (59.7); suboral zone, 62–73 (68.4); skirt, 11–16 (13.1)μ.

Length of lorica at lower temperatures (75° and below) is greater (240μ) than at higher ones (230μ).

At 23 stations, viz., at 1, 1, 5, 1, 2, 2, and 11, respectively, in California, Mexican, Peruvian and South Equatorial currents, Panamic Area, Galapagos Eddy, and Drift; at 68–83 (74.3)°; 59 loricæ.

Xystonellopsis heroica Kofoid and Campbell

Plate 21, figs. 1, 2

Lorica very elongate, slender, subcylindrical above and tapering conical below, consisting of bowl and horn; 6.21–7.39 (6.72) o.d. Upper bowl, lower bowl, and lance 3, 2, and 2 o.d. in length, respectively. Oral margin rounded, fairly thin. Oral rim with a concave sigmoid outer face, slightly flaring inner one, length 0.25 o.d. Suboral thickening very slight, increasing 50% at greatest diameter over wall below, 1 o.d. in length, gradually fading out aborally, with greatest

diameter (1.07–1.10 o.d.) near upper margin. Bowl 0.6 t.l., 4.26–4.74 (4.58) o.d. in length, subcylindrical above, widest, except for suboral zone, 1.03–1.10 (1.07) o.d., a little below middle with a wide zone of slight constriction above; consisting of upper subcylindrical part and inverted conical (24–28°) lower 0.4 length of bowl, with abrupt transition into lance. Aboral horn consisting of undifferentiated lance only. No pedicel or constriction. Lance subcylindrical, 1.72–2.68 (2.16) o.d. in length or 0.3 t.l., tapering (10°) in its distal 0.25–0.33, with basal diameter 0.08–0.16 of its length, thick-walled, with conical lumen in uppermost 0.3, and slender canal below to end. Tip rounded, closed. No lists. Wall thin, except in suboral region, hyaline, with homogeneous, thick inner and outer lamellæ enclosing minute primary prisms of regular form and uniform size, except for larger ones in horn, in 2 layers in suboral region, 1 in bowl, and 2–3 in upper part of lance, distinguishable in lower part of lance, and very faint elsewhere, elongated vertically in lance, recalling enlarged elongated prisms of knob of *heros*.

Ten loricæ: L., total, 174–218 (190.8); bowl, 115–147 (130.2); horn, 50–75 (61.6). D., oral, 26–31 (28.4); greatest, 28–32 (30.5); horn, 5–10 (7.3) μ.

At 18 stations, viz., at 2, 3, 2, 1, 3, 1, and 6, respectively, in California, Mexican, Peruvian and South Equatorial currents, Panamic Area, Galapagos Eddy, and Drift; at 66–85 (77.6)°; 32 loricæ.

Xystonellopsis heros (Cleve) Kofoid and Campbell

Lorica simple conical (6°), greatly elongated, without flare in skirt; aboral horn slender; 8.25 o.d. Oral margin flattened, without rim, flare, or suboral zone. Bowl not clearly differentiated from pedicel, 7.65 o.d. in length to skirt, with no marked change in slope. Pedicel feebly suggested by slight increase in taper and thickness of wall within 1.0 o.d. of lower end. Skirt not flaring or recessed, with rounded edge, 0.25 o.d. in diameter. Aboral horn an inverted cone (5°), 0.56 o.d. in length, sometimes curved, with central canal closing distally. Tip blunt. Lists low, restricted to lower 0.27 of combined bowl and pedicel, 4–5 on one side, not spiraled, but sometimes anastomosing. Wall subuniform in thickness throughout, with slight increase towards oral margin and more in pedicel; composed of equal, heavy, double-contoured inner and outer lamellæ enclosing 2–3 layers of fine prisms. Animal filling 0.7 of bowl, with 2 spheroidal macronuclei.

L., total, 450; bowl, 428; aboral horn, 32. D., oral, 58; skirt 16; base of horn, 8 μ.

At Sta. 4679 in Drift; at 69°; 1 lorica. Other records probably included with those of *tropica*.

Xystonellopsis inæqualis Kofoid and Campbell

Xps. dicymatica, K. and C., fig. 467, non p. 245.

Lorica elongate, fairly stout, bordered chalice-shaped, with short bowl, two suboral rings, long, very slender pedicel, narrow knob, and slender lance; 4.63–5.76 (5.25) o.d. Bowl, pedicel, and lance, respectively, 2.4, 2.3, and 0.51 o.d. in length. Oral margin thin, rounded. Oral rim everted (up to 150°), with concave outer and vertical or convex inner slope, 0.16–0.20 o.d. in length. Suboral thickened zone with two distinct rings, with broad region between of more than usual thickness, with length from ring to ring of 0.68–1.86 (0.73) o.d., and diameters of upper and lower rings, respectively, of 1.24–1.32 (1.28) and 1.32–1.56 (1.40) o.d.; with thickness of wall between rings 0.09–0.18 o.d., often increasing aborally, and subject to local irregularities. Bowl nearly equal in length (2.5–3.0 o.d.) to pedicel and lance, upper conical section 1.5–2.0 o.d. in length, an inverted cone of 5–18°, passing abruptly into lower inverted conical (38–50°) section, 1.00–0.55 o.d. in length. Pedicel extraordinarily long, 1.85–2.73 (2.31) o.d., and slender, 0.09–0.18 (0.14) o.d. in diameter, tapering distally slightly throughout 0.3–0.4 to 0.13–0.18 o.d. Knob squarish, recessed, spreading in four salient, acute, or rounded angles, with slight ridges running orally for a short distance upon pedicel, in a left-wound spiral, or vertical. Diameter of knob 0.15–0.27 (0.23) o.d. and its angle 20°. Lance slender, attenuate, 0.37–0.67 (0.51) o.d. in length, basal diameter 0.20–0.25 length, with conical canal to closed tip. Wall thickest in lower suboral ring almost uniform in bowl below, thickening gradually in pedicel, especially in lower end and knob, but very thin in lance; composed of double-contoured inner and outer lamellæ enclosing prisms uniform and regular at a given level, but largest in upper end between rings, 25 across one face; decreasing a little towards oral rim, and very rapidly on bowl and pedicel to one-third their diameter above, increasing again slightly on knob, and disappearing wholly in thin-walled lance; 4 layers in upper ring, 4–6 in lower, 2 in upper bowl, increasing to 3 in pedicel and 3–5 in knob. Animal with 2 macronuclei, each 8μ in diameter. Another one had 7 round macronuclei of the same size and shape, and may have been a post-conjugant or endomictic individual.

Ten loricæ: L., total, 246–305 (273.1); zone, 34–43 (38.1); pedicel,

98–142 (120.2); lance, 19–34 (26.7). D., oral, 48–54 (52.0); upper ring, 62–70 (66.7); lower ring, 64–80 (72.6); pedicel, 5–9 (7.3); knob, 8–14 (12.0)μ.

In our *Conspectus* we (1929, p. 240) inadvertently included as the type figure of *dicymatica* (fig. 467) a lorica which belongs to *inæqualis* (fig. 466). Both of these loricæ (fig. 466 of *inæqualis* and fig. 467 used in error for *dicymatica*) have the *wide* lower ring characteristic of *inæqualis*.

At 21 stations, viz., at 1, 1, 2, and 17, respectively, in Peruvian and South Equatorial currents, Galapagos Eddy, and Drift; at 68–81 (73.7)°; 60 loricæ.

Xystonellopsis krämeri (Brandt) Kofoid and Campbell

Lorica extremely elongated, attenuate awl-shaped, feebly differentiated into bowl and pedicel, with trace of skirt between pedicel and lance; 7.76–8.83 (8.28) o.d. Oral margin thin, rounded. Oral rim thinning down for short distance, with concave outer and flaring (up to 12°) inner slope. Bowl 0.22 t.l., with upper inverted, slightly convex subconical (1–2°) section, 4.0–4.5 o.d. in length, and lower inverted concave conical (10–15°) one, 1.8–2.0 o.d. in length, with gradual transition into horn. Aboral horn 1.75 o.d. in length. Pedicel subconical (up to 7°), 1.25–1.50 o.d. in length, and 0.25–0.45 o.d. in diameter. Lists 5–8, more or less interrupted, often spiral (left- or right-wound), with not to exceed 90° of revolution, except in one lorica with nearly 2 complete revolutions, formed by low, thin, prismatic ridges extending from skirt orally for 1.0–2.3 o.d. Skirt narrow, not flaring, slightly angular, not recessed, with basal diameter slightly exceeding that of lance. All gradations from a trace to a well defined but narrow skirt appear in our loricæ. Lance a cone of 10–18° with blunt tip, 0.36–0.52 (0.45) o.d. in length, with basal diameter 0.33–0.50 length and conical central canal occluded in its distal half. Wall very thin, composed of the two homogeneous lamellæ enclosing very small, regular secondary prisms, becoming larger aborally near lance. Wall in bowl composed of 3 layers of prisms above, and of 2 layers only in lower end of lower cone, thickening distally in knob to 5 layers of prisms. Lists formed by 5–6 superimposed rows of prisms. Prisms of any given level uniform in size, hexagonal in surface view, and elongated vertically in aboral horn; 150, 100, 26, and 40 prisms on successive levels of bowl. Animal large, with 2 oval macronuclei 8 by 16μ, with a small micronucleus adjacent to each.

Eight loricæ: L., total, 535–618 (575.7); to skirt, 503–578 (544.1); lance, 25–40 (31.6). D., oral, 67–73 (69.5); pedicel, 12–21 (16.5); skirt, 7–14 (11.6) μ.

At 13 stations, viz., at 2, 1, 4, and 6, respectively, in Peruvian and South Equatorial currents, Easter Island Eddy, and Drift; at 67–77 (71.9)°; 19 loricæ.

Xystonellopsis laticincta Kofoid and Campbell

Plate 20, fig. 9; Plate 22, figs. 5, 6, 12

Lorica elongate, broadly banded chalice-shaped, with bowl and horn subequal, primary and secondary or even tertiary skirts, and a very short, sharp lance; 6.37–7.00 (6.75) o.d. Bowl, upper and lower pedicels, and lance, respectively, 2.9, 1.9, 1.47, and 0.4 o.d. in length. Oral margin thick, rounded. Oral rim concave outwardly, or even peripherally everted, convex internally, 0.18–0.25 o.d. in length. Suboral zone heavy, thick-walled, with prominent upper, and less prominent lower, suboral ring; 0.88–1.09 o.d. in length, with diameters on upper and lower rings 1.24–1.42 (1.35) and 1.16–1.30 (1.22) o.d., respectively, with interannular zone convex outwardly, as wide as rings, wider above, slightly concave below. Upper bowl below band tapering slightly, an inverted convex cone of 5°, 2.0 o.d. in length including suboral zone, contracting more rapidly into inverted convex conical (35–40°) lower bowl, 1.0 o.d. in length, passing gradually into pedicel, 1.75–2.00 o.d. below zone. Distance from oral rim to transition into pedicel equaling that from this level to skirt. Pedicel duplicated in two distinct subcylindrical parts, an upper wider section, 0.25 o.d. in diameter and 1.51–2.00 o.d. in length, and a narrower, concave, less uniform section, 0.12 o.d. in diameter, with length to skirt as little as 0.9, but generally 1.39–1.51 (1.45), o.d.; flaring abruptly into knob. Knob very large, angled, with upper primary skirt with 4–9 projecting angles with reentrant bays between, with sharp-edged, non-spiral wings ascending lower segment of pedicel for a short distance, with diameter at skirt 0.47–0.52 o.d., and angle of 45°. Knob curiously repeated in smaller, secondary, lower section with similar angles, and in one lorica there are two such repetitions of these angular, recessed, skirt-like projections. Lance short, inverted conical (10°), less than diameter of knob, or 0.41–0.52 (0.43) o.d. in length, with occluded central canal continued from expansion in knob. Tip closed, rounded. Wall with thin inner and outer lamellæ enclosing regular prisms of uniform size at given levels, 10 layers in oral rim, 3 in suboral zone, 1 in

lower bowl, upper pedicel, and lance, 2–4 in lower pedicel, and 3–5 in knob, 80–90, 32, 26, 20, 9, and 20–28 across one face on oral rim, suboral band, upper bowl and lower bowl, upper pedicel, lower pedicel, and knob, respectively. Those in oral rim extraordinarily small, with abrupt transition to larger prisms in zone.

Five loricæ: L., total, 306–343 (324.0); bowl, 135–138 (141.2); upper pedicel, 85–101 (92.8); lower pedicel, 68–77 (70.0); lance, 18–26 (20.8). D., oral, 46–51 (48.0); upper ring, 62–66 (64.7); lower ring, 56–60 (58.7); skirt, 23–26 (24.2); upper pedicel, 11–13 (12.0); lower pedicel, 5–7 (6.0) μ.

At 6 stations, in Drift; at 72–82 (76.4)°; 7 loricæ.

Xystonellopsis ornata (Brandt) Kofoid and Campbell

Lorica stout, subconical (10°), vase- or tall goblet-shaped, with a much swollen aboral end, locally thick-walled, but very delicate and translucent; 3.55–4.82 (4.17) o.d. Oral margin thin, sharp. Oral rim 0.14–0.20 o.d. in length, deeply concave outer and vertical inner face. Suboral zone broad, 1.16–1.50 (1.35) o.d. in length, formed by thickening of wall, with upper and lower marginal annular ridges, or rings, triangular in cross section; upper ridge smaller, concave above and less so on its lower surface; lower about twice size of upper, concave on lower surface and plane and oblique above. Wall between two rings thicker than above or below zone. Lower ridge (1.32–1.48 o.d.) often somewhat wider than upper (1.16–1.32), so that zone is contained in segment of cone 15–20°. Connecting the two rings are 9–13 thin, vertical ridges, or wings, with straight, sinuous, or traces of a left spiral direction, sometimes distended outwardly in their middle. Bowl below zone not readily separable into typical upper and lower sections, conical (15–22°), 1.5–2.0 o.d. in length, and 0.66–0.75 o.d. at level of enlarged, thicker-walled aboral region, whose length, including lance, is 0.37–0.40 t.l. or 1.3–2.0 o.d., and greatest diameter 0.5–0.8 o.d. Thick-walled section representing lower end of bowl, pedicel, knob, skirt, and lance of Xystonelloides; irregularly conical (up to 10°) above, with undulating outline due to irregularities in thickness, faintly suggesting presence in the contour of several turns of left-wound spiral, but with no trace of spiral lamina or lists. Lorica contracting below this section in inverted irregular cone (45–50°) 0.50–0.65 o.d. in length, with change of slope to lance. Lance short, stout, subconical (20–30°), blunt, not over 0.5 o.d. in length, with basal diameter 0.5–1.0 its length, with median inflation of central canal, sometimes irregular in contour,

always closed at tip. Wall remarkably translucent and delicate, so much so that lorica is easily overlooked unless illumination of field is cut down; consisting of regular prisms, 1 layer in rim, 4 in upper, and 8, becoming smaller peripherally, in lower ring, 2 in suboral zone, 1 of large prisms for up to 0.5 o.d. below lower ring in bowl, 2 of small prisms in bowl below, increasing from 2 to 12 in thick-walled aboral section and 6–2 in lance. Prisms as seen on surface quite regular and symmetrical, but varying greatly in size in different sections and at different levels below surface in aboral region, being finer by 3 to 1 near canal than at surface. Smaller areas found on lance, lower part of bowl, and in edges of rings and oral rim. Primary prisms inside of secondary ones are exceedingly faint. Animal large.

Ten loricæ: L., total, 200–269 (234.1); suboral zone, 36–50 (41.5); cavity, 138–204 (173.8); pedicel, 20–25 (22.1). D., oral, 51–60 (56.1); lower ring, 70–80 (76.8); posterior expansion, 28–48 (37.4) μ.

Two types occur at Sta. 4571, a large (269 μ) and a small (200 μ) form which are widely divergent except in oral diameter. Intergrades occur at other stations. Similar large and small forms occur in *Xystonellopsis pulchra*, *Salpingella acuminata*, and *Daturella datura* at this same station. There is no evidence of any correlation between temperature and size in this species, the effect of temperature differences on linear dimensions possibly masked in thick-walled horn.

At 16 stations, viz., at 4, 5, 3, 1, and 3, respectively, in California and Peruvian currents, Panamic Area, Galapagos Eddy, and Drift; at 68–83 (73.1)°; 48 loricæ.

Xystonellopsis paradoxa (Cleve) Jörgensen

Lorica elongated, subconical (8–10°), stout, tapering vase-shaped; 4.14–4.71 (4.52) o.d. Oral margin narrow, blunt. Oral rim with increased distal flare (15°), 0.20–0.25 o.d. in length, measured from upper limit of thickened zone, outwardly concave or sigmoid, inwardly distally convex. Suboral zone thickened, 0.75–1.00 o.d. in length, without rings or roll, though occasionally with slight concavity in middle indicative of tendency to form thicker regions at upper and lower margins, with more gradual merging into normal wall on lower edge than on upper. Bowl 0.75–0.78 t.l., faintly separable into upper and lower bowls; upper an inverted cone (5°), 2.2 o.d. in length, contracting from 1.2 on widest part of suboral zone to 0.9 o.d. below; lower 1.0 o.d. in length, an inverted cone of 15°, 0.50–0.75 o.d. in length. Pedicel thick-walled, constricted above knob, 0.5 o.d. in length and 0.6–0.8 in diam-

eter above knob, with 8–10 linear, sinuous, or left-wound ridges running orally from upper skirt for 1 o.d., entirely lacking on some loricæ. Knob and skirt duplicated, upper knob flaring (40–50°), 0.75–1.04 (0.88) o.d. in diameter, 0.3–0.4 o.d. in length, recessed, with skirt angled by lower ends of ridges with asymmetrical reëntrant bays between. Lower, or secondary, knob smaller than upper, somewhat resembling it in form but less flaring, 0.75 o.d. in diameter above, 0.4–0.5 at constriction, 0.5–0.6 at skirt, and 0.23–0.45 o.d. in length, in shape like the drum of a winch with unequal, or evenly divided, concave slopes between the two skirts. In most loricæ lower knob traversed by 6–8 vertical, oblique, sinuous, or right-wound spiral ridges, highest at middle. Lance 0.64–1.22 (0.70) o.d. in length, basal diameter 0.4–0.6 its length, with short conical (60–65°) base tapering distally 10–20°, with central canal tapering from ellipsoidal expansion in lower knob. Tip acute, closed. Wall delicate, hyaline, but not so much as in *ornata* or *Climacocylis scalaria*, composed of fine, regular, quite uniform prisms, about 90 across one face on widest part of suboral band, with 2 layers in lower part of bowl, 5 in suboral zone, and 12 in upper skirt.

Eight loricæ: L., total, 182–218 (197.2); to skirt, 142–164 (151.0); between skirts, 13–21 (16.4); lance, 27–50 (33.0). D., oral, 41–46 (43.6); suboral zone, 46–52 (49.0); upper skirt, 32–46 (38.4); lower skirt, 19–33 (24.0) μ.

At 20 stations, viz., at 1, 1, 1, 3, and 14, respectively, in California, Peruvian, and South Equatorial currents, Easter Island Eddy, and Drift; at 67–82 (75.4)°; 26 loricæ.

Xystonellopsis parva spec. nov.

Plate 21, figs. 5, 8, 9

Lorica stout, tapering, awl-shaped, contracting below suboral ring to 1.0 o.d., expanding again below to 1.1 o.d., tapering to lance without differentiation of pedicel; 6.1 o.d. Upper bowl, lower bowl, and lance approximately 3, 2, and 1.2 o.d. in length, respectively. Oral margin bluntly rounded. Oral rim thinning down in upper 0.3. o.d., in section an angle of 18° with outer and inner slopes equally convex. Suboral thickened zone 0.25 o.d. in thickness and 1.6 in length, thinning gradually aborally, with diameter in widest part (1.24 o.d.), located 0.7 o.d. below oral rim. Bowl 0.8 t.l.; upper section subcylindrical, except for bulging suboral zone, 0.65 length of bowl; lower conical, 25°, abruptly increasing to 45° at transition to horn. Aboral horn without pedicel

or constriction. Lance a slender, tapering cone of 12° measured with lists, cylindrical above beneath lists, 1.2 o.d. in length, with narrow central canal. Tip rounded, closed. Lists, 4, subvertical, subequally extended on bowl and lance, length 0.5 o.d. Wall of small, regular secondary prisms in one row of radially placed hexagonal polyhedrons between thick inner and outer lamellæ, except for 2–4 layers in suboral band and lance region. Prisms uniform in size at a given level, 35, 30, 26, 28, 12, and 2–3, respectively, on suboral band, constricted region, expanded region below, middle of lower bowl, upper end of lance, and middle of lists.

Two loricæ: L., total, 175–177; bowl, 140–147; horn, 30–35. D., oral, 26–32; suboral zone, 36μ.

At Sta. 4701 in Drift; at 72°; 2 loricæ.

Xystonellopsis pinnata Kofoid and Campbell

Plate 21, fig. 12

Lorica elongated, anteriorly cylindrical chalice-shaped, posteriorly tapering subconical, with the two regions subequal in length, consisting of bowl and lance only, enlarged at junction due to lists; 5.54–5.68 o.d. Upper bowl, lower bowl, and horn 2.6, 1.7, and 1.5. o.d. in length, respectively. Oral rim thin, barely sigmoid outwardly, 0.18 o.d. in length. Suboral thickening 1.0 o.d. in length, thinning out aborally very gradually. Bowl 0.77 t.l., or 4.04–4.24 o.d. in length, upper subcylindrical above for 0.45 t.l., or 0.65 length of bowl, lower an inverted cone of 30°. Transition into horn moderately abrupt. Aboral horn consisting of little more than the lance set into lower cone; subconical (12–15° including lists, or 8° below), 1.43–1.50 o.d. in length, with basal diameter 0.12–0.17 length. Base of horn in one lorica locally swollen. Lists vertical, 5 (?) in number, 0.9–1.2 o.d. in length, extending equally on bowl and lance, with convex or straight edge. Central canal at upper end, 0.33 diameter of horn at that level, tapering below to slender canal reaching closed tip.

Two loricæ: L., total, 154–159; bowl, 113–119; lance, 40–42. D., oral, 28; greatest diameter on thickened zone, 29; lance at base with fins, 8–12μ.

At 2 stations, viz., at 1 each in Panamic Area and Drift; at 75–80 (77.5)°; 2 loricæ.

Xystonellopsis pulchra (Kofoid) Kofoid and Campbell

Plate 22, figs. 10, 14

Lorica tall, chalice-shaped, with 3 or 4 suboral rings, a short lower bowl, long, slender pedicel, small knob, slightly flaring skirt, and slender lance; 5.34–7.65 (6.08) o.d. in length. Bowl, pedicel, and lance, respectively, 3.2, 2.3, and 0.52 o.d. in length. Oral margin very narrow, rounded. Oral rim thinned, flaring, vertical or incurved, 0.20–0.28 o.d. in length to summit of first suboral ring, with deeply concave outer face and vertical or distally flaring (10°) inner face. Suboral zone exceptionally wide, attaining maximum development in subgenus, 1.05–1.95 (1.54) o.d. in length, and, measured to rim, including upper 0.4–0.6 of bowl; a region of more or less general and variable thickening of wall, consisting of 3 or 4 suboral rings, usually of unequal spacing; the first and second rings farther apart (0.65–0.80, generally 0.75, o.d.) than middle and lowest, or third, rings, 0.55–0.60, rarely up to 0.45, o.d. Great variation in diameters, scarcely two loricæ being alike either in relative or absolute dimensions of rings; tabulation of relative diameters of the 3 rings on 20 loricæ yielding the following sequence of diameters from smallest to largest in 10 or 11 of the 20, viz., first ring smallest (10 loricæ), third ring next (11), and second ring largest (10). All other possible combinations occur, but the lowest ring is largest only in a single deformed lorica. These differences in diameter are correlated with differences in vertical length, the sequence from least to greatest being the same in the majority of cases, with many other combinations. Usually the uppermost ring has much less than half the width of the middle one, and the lowest is smaller and less filled out than the middle one. This relation is further correlated with the greater width between the uppermost and middle rings and the greater thickness of the wall in this region as compared with that between the middle and lowest rings. Deposition of wall substance thus exhibits three waves, reaching a maximum in the middle one, with a lingering subsidence on the upper suboral band and a minimum amplitude in the final ring. Indications of the interpolation of another ring between the middle and topmost ones are to be seen in feebly developed undulations in the upper suboral band. Greatest diameter on suboral rings 1.27–1.78 (1.38) o.d. Bowl 0.55–0.60 t.l., with upper bowl convex subconical (1–5°), 2.5–3.0 o.d. in length, passing with abrupt shoulder into short lower bowl, an inverted convex cone of 27–35°, 1.00–0.75 o.d. in length. Pedicel elongate cylindrical, with traces of irregular constriction above knob, indicative of initial stages of formation of

duplicated lower section seen in *clevei;* with length and diameter 1.82–3.09 (2.34) and 0.24–0.33 (0.27) o.d., respectively. Knob with flare of up to 10°, more or less ridged. Skirt of quadrangular outline, from whose angles, and often also from intermediate points, salient ridges pass subvertically or in a slightly left-wound spiral orally on pedicel for 0.6 o.d. Quadrangular form gives way to an undulating, more or less circular one in a few loricæ. Skirt 0.24–0.37 (0.33) o.d. in diameter, a trifle larger than pedicel, though in a few loricæ smaller than pedicel above distal constriction. Lance 0.45–0.66 (0.52) o.d. in length, with basal diameter 0.2 length; slender, attenuate, and almost cylindrical with central canal below enlargement in knob extending to closed tip. Wall with double-contoured inner and thin outer lamellæ enclosing secondary prisms, with finer primary ones within each. Prisms largest in upper half of bowl up to top ring, in and above which they are abruptly smaller, decreasing to 0.5 of that diameter below ring, also decreasing to about same degree in pedicel, increasing again abruptly in thick-walled part of this and in knob, and fading out upon thin-walled lance; 4–8, 1, 1, 4–6, and 1 rows, respectively, in suboral rings, bowl, pedicel, skirt, and lance, presenting a remarkably regular and uniform secondary hexagonal mesh at a given level in surface view. Knob tinged with yellowish brown, and the whole lorica of delicate texture and quite translucent. Animal frequently seen, quite small, attached laterally near middle of lorica, with 18–22 membranelles, 2 ovoidal or globular macronuclei, 10 by 20μ, each with an adjacent globular micronucleus, 5–9μ. Binary fission, as in other Tintinnoinea, taking place by formation of new peristome on side of body, and with accumulation of siderophile granules near oral opening.

Ten loricæ: L., total, 315–427 (375.1); zone, 64–115 (94.9); pedicel, 120–178 (144.1); lance, 24–36 (32.0). D., oral, 54–68 (61.7); greatest, 80–96 (85.4); pedicel, 15–19 (16.5); skirt, 15–22 (19.1)μ.

Remarkably variable, forming a complex without parallel in the genus, especially at Sta. 4713 a region of upwelling cold water and rapid vertical decrease in temperature. Comparable variations occur here also in *Xystonella treforti.* They consist, in *pulchra,* in reduction in thickness of suboral region with partial suppression of rings, foreshortening of pedicel, abnormal asymmetry of skirt, and even obliteration of all rings but the top one, reduction of skirt, and suppression of lance. At Sta. 4648 occurred one lorica with a normal suboral region, but complete reduction of pedicel to a stout aboral horn like that of *Xystonella acus,* only very much stouter.

At 22 stations, viz., at 3, 1, 6, 1, 3, 1, 2, and 5, respectively, in Cali-

fornia, Mexican, Peruvian and South Equatorial currents, Panamic Area, Easter Island and Galapagos eddies, and Drift; at 67–83 (73.4)°; 63 loricæ.

Xystonellopsis spicata (Brandt) Jörgensen

Lorica rather short, stout chalice-shaped, with widely conical nonstriate pedicel, and long, slender lance; 3.96–4.55 (4.22) o.d. Upper bowl, lower bowl, pedicel, and lance, respectively, 2.0, 0.6, 1.4, and 0.6 o.d. in length. Oral margin rounded. Oral rim thinned, with concave outer and slightly flaring (5°) inner slope, 0.25–0.29 o.d. in length. Suboral thickened zone not concentrated in a ring, 1.10–1.20 (1.13) o.d. in diameter, 0.4–0.7 o.d. in length, thinning rapidly aborally. Bowl 0.57 t.l., with abrupt shoulder between upper and lower cones; upper inverted cone of 10°, 2.0 o.d. in length; lower of 25–30°, 0.6 o.d. in length, becoming concave below. Pedicel 12–20°, conical, not clearly delimited anteriorly, its upper diameter twice that at skirt with slight constriction above, 0.66–0.92 (0.84) o.d. in length, with diameter at skirt same as pedicel immediately above, 0.15–0.24 (0.19) o.d. Skirt without striæ or recess. Lance very slender conical (5°), with or without conical (up to 30°) basal flare, 0.58–0.81 (0.71) o.d. in length, and basal diameter 0.12–0.20 length, with central canal occluded distally. Wall rather thin, 0.10–0.21 o.d. in suboral zone, decreasing aborally to 0.03 in pedicel, composed of very thin inner and outer lamellæ enclosing 1–3 layers of minute primary (?) regular prisms, smaller in oral rim, largest (3-layered) in suboral zone, about 40 across one face, growing rapidly smaller in lower cone and pedicel, decreasing to 0.3 diameter of those above, with 1 layer in lower bowl and pedicel and 2 in skirt. Much less difference in dimensions of prisms at different levels in this species than in *cyclas* and *crassispinosa*.

Seven loricæ: L., total, 197–214 (203.8); to skirt, 163–177 (169.3); bowl, 123–130 (128.8); pedicel to skirt, 30–46 (40.4). D., oral, 47–51 (48.3); suboral zone, 52–61 (54.3); midway, 37–40 (37.1); pedicel, 7–13 (9.1); skirt, 6–12 (9.0) μ.

At 18 stations, viz., at 1, 5, 2, and 10, respectively, in Peruvian Current, Easter Island and Galapagos eddies, and Drift; at 69–79 (73.1)°; 56 loricæ.

Xystonellopsis tenuirostris (Brandt) Kofoid and Campbell

Lorica elongated, tapering chalice-shaped, with stout pedicel, slight skirt, and short, stout conical lance; 4.46–6.18 (5.43) o.d. Upper bowl, lower bowl, pedicel, and lance, respectively, 2.2, 0.8, 1.0, and 0.5 o.d.

in length. Oral margin rounded. Oral rim thinned, everted, with subvertical or concave spreading outer slope and flaring (up to 11°) inner one, 0.16 o.d. in length. Suboral thickened zone expanding to 1.10–1.16 (1.13) o.d. at 0.13–0.16 o.d. below rim; 1.0–1.5 o.d. in length, sharply differentiated aborally in loricæ with narrower zones, blending aborally with upper bowl in those with wider zones. Bowl 0.6 t.l., with scarcely differentiated shoulder between upper and lower cones; upper an inverted cone of 8–12 (10)°, 2.2–3.0 o.d. in length; lower, 15–24° and 1.0–2.0 o.d. Transition into aboral horn very gradual. Pedicel concave cylindrical, with 8 leiotropic or subvertical striæ passing orally from skirt for up to 1.5 o.d. Skirt flaring, up to 20°, with diameter 1.25–2.00 that of narrowest part of pedicel, or 0.21–0.36 (0.28) o.d., recessed below, subcircular in outline, with undulations or angles at striæ. Lance stout, conical (up to 20°), sharp-pointed, 0.37–0.75 (0.49) o.d. in length, with basal diameter nearly equal to that of narrowest part of pedicel, or 0.25–0.50 length, with conical central canal from expansion in knob to closed tip. Wall thickest in suboral zone, thinning in upper and lower bowl, gradually thickening towards lower end of pedicel or throughout its length and in lance; composed of thin outer and inner lamellæ, and the intervening layer of minute secondary prisms, 1–2 layers in oral rim, 4–5 in suboral zone, 2 in upper bowl, 3 in pedicel, 6 in skirt, and 2–3 in lance; a little larger in suboral band and pedicel than elsewhere, 60–65 across one face in suboral zone. Animal with 2 micronuclei and 2 large macronuclei, reported by Brandt (1907) and found by us.

Eight loricæ: L., total, 216–304 (269.6); to skirt, 198–284 (245.1); lance, 18–36 (24.5). D., oral, 47–52 (49.6); suboral zone, 54–59 (56.0); skirt, 10–17 (13.7) μ.

At 20 stations, viz., at 3, 1, 2, 2, and 12, respectively, in Mexican and South Equatorial currents, Panamic Area, Galapagos Eddy, and Drift; at 70–84 (77.6)°; 48 loricæ.

Xystonellopsis torta (Kofoid) Kofoid and Campbell

Plate 22, figs. 1, 11

Lorica banded chalice-shaped, with a very heavy suboral band, wide interannular zone, long tapering lower bowl, stout pedicel, large knob, and relatively short lance; 5.78–6.95 (6.36) o.d. Bowl, pedicel, and lance, respectively, 1.67, 2.68, and 0.46 o.d. in length. Oral margin and rim similar to those of *pulchra*, 0.25–0.32 o.d. in length. Suboral zone 0.40–0.52 length of bowl in length, and longer in loricæ in which

interannular zone between first and second rings is long and fifth ring incipient; its length, measured to oral rim, 0.19–0.30 (0.25) t.l., or 1.23–1.82 (1.56) o.d., and greatest diameter, usually at third ring, 1.46–1.65 (1.53) o.d. Suboral zone typically with four rings, unequally differentiated, first and fourth better differentiated, also the third in loricæ in which interval between first and second is wide, and second least sharply set off, remaining as a wide, convex interannular zone. A second distinct ring sometimes emerging in a zone of morphological instability between first and third rings. Loricæ with a long interannular zone between first and second rings often having a suggestion of an additional incipient ring. Relative diameter of rings varying greatly, but usual order from narrowest to widest being: — first, fourth, second, third. Bowl, including suboral zone, 0.5 t.l.; upper bowl a convex inverted cone (5°), 2.6–3.0 o.d. in length, tapering slightly less in loricæ with long suboral zone than in those with shorter ones, with gradual transition; lower an inverted convex cone of 35° in wide-zoned loricæ, and less (20°) in narrow-zoned ones, 0.6–1.0 o.d. in length. Pedicel stout, cylindrical, or slightly tapering, its length to skirt and diameter 2.13–2.86 (2.64) and 0.27–0.34 (0.30) o.d., respectively; passing with a little constriction into enlarged knob and angled skirt, with diameter greater than lower end of pedicel. Knob abruptly truncate, recessed, with 5–8 salient angles in skirt from which low, sharp-angled ridges pass upwards on pedicel in a steep (up to 40°) left-wound spiral for two diameters of skirt. Lance short, slender conical (8°) to almost cylindrical, 0.43–0.52 (0.46) o.d. in length, tapering near end to rounded closed tip. Wall of regular prisms uniform at a given level, smallest in oral rim and pedicel, largest in suboral zone below first ring, 33 on one face on third ring, 33 and 50 across bowl below ring and at upper end of lower bowl, 50 across pedicel, and 21 across knob; in 6–8 layers in first ring, 5–6 in others, and 2–3 in intervening regions, 1 in bowl below rings and in pedicel to level of constriction of lumen to a narrow canal in knob, 4 in knob, and 1 faintly marked layer in lance. One animal seen with 4 macronuclei, each 12μ in diameter, probably preceding binary fission.

Five loricæ: L., total, 364–466 (413.6); zone, 80–122 (101.6); pedicel, 132–192 (174.6); lance, 27–35 (30.2). D., oral, 63–67 (65.0); greatest, 98–104 (99.6); pedicel, 17–22 (19.6); skirt, 22–28 (25.4)μ. Kofoid's lorica (1905, pl. 28, fig. 16) is 465, 83, 192, 40, 70, 90, 19, and 30μ, from his original drawings.

At 3 stations, 1 each in California and Peruvian currents and Galapagos Eddy; at 69–75 (71.6)°; 77 loricæ.

Xystonellopsis tropica spec. nov.

Non *Undella heros* Cleve, 1900d, p. 974, fig. [11].
Undella ? (*Xystonella*) *heros*, Brandt, 1906, pl. 42, figs. 1, 1a, 2.
Xystonella heros, Brandt, 1907, p. 184; Laackmann, 1909, pp. 476–479.
Xystonellopsis heros, K. and C., 1929, p. 247, fig. 485.

Lorica very large, greatly elongated, clearly divisible into bowl, skirt, and lance, but pedicel not differentiated from bowl by slope; 6.76–8.35 (7.73) o.d. Oral margin broadly and evenly rounded. No rim, flare, or suboral zone. Bowl 0.25–0.20 t.l., merging gradually into pedicel, its lower limit at upper ends of striæ, coinciding with slight change in contour. Bowl 0.78–0.89 of length from oral margin to skirt, subdivided by changes in slope into upper slightly subconical (up to 2°) or cylindrical section 4.0–4.5 o.d. in length, and lower conical (10–15°) one 2.25–3.00 o.d. in length. Pedicel short, 1.0–1.5 o.d. in length and 0.18–0.28 o.d. in diameter in its narrowest region, 0.4 o.d. above skirt. Lists longitudinal, 6–9, running orally for 1.25–2.00 o.d. from skirt, terminating on edge in slight angles, each a thin fold of outer lamella enclosing prismatic areas and running vertically or spirally in a right- or left-wound spiral with a revolution of not more than 90°, rarely up to 180°; often interrupted or isolated, and even reversed in direction of torsion from right- to left-wound in lower part of course. Skirt, or incipient knob, formed by abrupt distal flare (up to 32°) to 0.28–0.31 (0.30) o.d. Lance 0.54–0.75 (0.61) o.d. in length, conical (10–17°), with conical central canal with no flare above, and rounded closed tip. Wall composed of thin, homogeneous inner and outer lamellæ enclosing small, regular, secondary prisms increasing in size in aboral region; uniform in thickness in bowl; composed of 2–3 layers of prisms above and 1 only in lowermost part of lower cone, thence distally rapidly thickening in skirt, number of layers of prisms gradually increasing to 5 in pedicel and knob, occluding lumen to slender canal. Lists with prisms in as many as 5 superposed rows. Prisms at any given level uniform in size, hexagonal in surface view, elongated in aboral region in direction of main axis as though under stress. Number across one face 150, 100, 28, and 35 on upper part of bowl, middle of lower cone, narrowest part of pedicel, and skirt, respectively. Animal with 2 ovoidal macronuclei 15 by 20μ, each with an adjacent spheroidal micronucleus 10μ in diameter.

Ten loricæ: L., total, 473–604 (546.2); to lance, 433–557 (503.1); lance, 37–50 (43.1). D., oral, 67–78 (70.6); pedicel, 16–26 (20.6); skirt, 19–24 (21.1)μ.

Included by us (1929, p. 247) in *Xps. heros* (Cleve) in agreement with Brandt (1906, 1907), but separated here as a distinct species because of its basic incongruity with Cleve's species in shape of bowl, having upper and lower sections instead of a single cone; pedicel delimited by slight change in contour, contraction of lumen, interrupted instead of regular striæ; and skirt expanded into a knob, instead of rounded into the lance. All of these features serve in the distinction of other species in the subgenus Paraxystonellopsis. They are so prominent that it seems improbable that Cleve (1900d) could have overlooked them.

At 33 stations, viz., at 2, 2, 12, 4, 1, and 12, respectively, in California, Mexican and Peruvian currents, Panamic Area, Galapagos Eddy, and Drift; at 66–83 (72.2)°; 66 loricæ.

Xystonellopsis turgida spec. nov.

Plate 18, figs. 2, 3; Plate 20, fig. 10

Lorica bullet- or tall goblet-shaped, convex conical (17°), with a distinct bowl, pedicel, knob, and lance; 3.44 o.d. Oral margin thin, sharp. No differentiated rim. No suboral thickened zone. Bowl 0.66 t.l., its upper 0.4 convex subconical (5°), its lower 0.6 less convex subconical (30°), contracting at 2.25 o.d. from rim to 0.31 o.d. at transition into pedicel. Pedicel measured to skirt 0.5 o.d. in length, constricted above skirt, with upper section broadly fusiform, widest in its middle; its greatest diameter 0.33, and its least, just above knob, 0.14 o.d. Knob flaring abruptly in low cone (90°), with horizontal skirt with rounded circular edge without angle or striæ, 0.24 o.d. in diameter. Lance 0.55 o.d. in length, conical (8°), flaring at base (25°), with basal diameter 0.16 length, with conical central canal. Tip closed, sharp-pointed. Wall relatively thin, 0.04 o.d., not thickened suborally, and scarcely in knob; similar to that in *epigrus*, but with thinner inner and outer faintly double-contoured lamellæ enclosing a sheet of fine primary prisms.

L., total, 146; bowl, 98; pedicel and knob, 22; lance, 26. D., oral, 44; pedicel, 13; skirt, 11 μ.

At Sta. 4734 in Drift; at 81°; 1 lorica.

XI. UNDELLIDÆ Kofoid and Campbell

Tintinnoinea with short, stout, cup- or goblet-shaped, rarely elongated, tubular, or flask-shaped lorica; oral margin thinned, sharp, in Undellopsis thickened suborally to a ledge; lorica not differentiated

into flaring collar and bowl, at most only to anterior cylinder and bowl, often cylindrical or tubular; aboral region undifferentiated, tapering, or inflated, with or without angular outline; aboral end hemispherical, rounded, obtuse, acute, pointed, mammillate, introverted, or umbonate, but never differentiated into aboral horn; lorica unmodified; or with rings, suboral, equatorial, or on an anterior cylinder, but never with spiral structure; wall trilaminate, secondary structure in intermediate layer evident in some species; closing-apparatus sometimes seen; marine, in warm temperate and tropical seas.

Differs from all others in simplicity of structure of wall, with double-contoured outer and inner lamellæ and intermediate homogeneous or faintly prismatic layer, and in simple shapes and proportions of lorica which lacks both suboral and aboral specialization. Nearest to Xystonellidæ and Parundella, but lacks elongated pedicellate aboral region characteristic of them.

Contains six genera: Proplectella (23 species), Undella (18), Amplectella (8), Amplectellopsis (2), Undellopsis (14) and Cricundella (3).

This family is primitive in respect to small tubular or tapering loricæ of Undella and Proplectella, which approach in type and proportions the simpler species of Tintinnidium and Tintinnopsis, but exhibit a refinement of material used in wall of lorica and an orderliness and precision in pattern of lorica not realized in these more primitive genera. Typically eupelagic oceanic organisms with opportunities for a selected diet and uniformity of behavior which are less available for species belonging to the neritic fauna.

27. PROPLECTELLA Kofoid and Campbell

Undellidæ with short lorica, generally shaped like bowl of a stout goblet; oral margin abruptly acute in section; suboral region always contracting orally; inner collar usually present, formed by localized suboral thickening of inner side only of wall; never with an outer suboral ledge; no differentiation of bowl and horn; rings absent; aboral end variously rounded, pointed, angled, or truncated; no longitudinal structures; wall hyaline, trilaminate, with structureless intermediate layer; marine, in temperate and tropical seas. Type species *Proplectella claparèdei* (Entz, Sr.) from stomach contents of Salpa in North Atlantic.

Proplectella, like Undella, is one of the simpler genera of Undellidæ in point of shape and undifferentiated structure of lorica, and is, in

addition, made up of small species only. It differs from all other Undellidæ in having an inner collar. It is neither so elongated nor so large as Undella, never has rings as Amplectella, Amplectellopsis, Cricundella, and Undellopsis, and has no suboral ledge as Undellopsis. In form and proportions distinctly more nearly related to the more primitive genus Undella than to the ringed genera, Amplectella, Amplectellopsis, Cricundella, and Undellopsis. The family Undellidæ, through Proplectella, is connected with Parundella of the Xystonellidæ. Indications of the structural relationships of these two genera are seen in the similarity in shape, size, and proportions of the smaller species of Parundella, such as *minor, grandis,* and *lachmanni,* to the larger, more slender species of Proplectella. Another resemblance is seen in the thinning out of the wall aborally in *parva* and *subcaudata,* as in many species of Parundella. The difference between the two genera lies in the absence of the inner collar in Parundella, but this difference is slight in such species as *subacuta* and *prælonga.*

Proplectella was established by us (1929) out of species previously included in Tintinnus and later in Undella.

Contains 23 species, of which 17 are found in Expedition material. Of these 23, 12 were new, and 11 included in this Report. Subdivided into four series: — the *columbiana* series, including *columbiana, perpusilla, tumida, claparèdci, prælonga, fastigata,* and *ovata;* the *subacuta* series, including *subacuta, ostenfeldi, globosa, tenuis,* and *angustior;* the *parva* series, including *parva, subcaudata, acuta, ellipsoida, cuspidata,* and *grandis;* and the *urna* series, including *urna, subangulata, biangulata, pentagona,* and *amphora.*

Proplectella amphora Kofoid and Campbell

Plate 23, fig. 13

Lorica truncated biconical pot-shaped, with angular premedian expansion and flat aboral end; 1.93–2.10 (1.96) o.d., or 1.2 greatest diameter. Oral margin sharp, in section an angle of 35–40°. Oral aperture 0.48–0.57 (0.52) t.l. in diameter. Oral region everted in a truncated segment of a straight-sided inverted cone of 10–15°. Inner collar 0.18–0.21 (0.19) t.l., in length, with prominent rounded nuchal angle. Nuchal diameter 0.84–0.92 o.d. Suboral thickening increasing from oral margin to nuchal level, decreasing thence to normal wall of bowl at shoulder. Lorica above shoulder outwardly a segment of a cone of 47–52°, 0.4 t.l., with almost flat sides. Bowl expanding evenly from oral margin to greatest diameter (1.56–1.73 [1.61] o.d.) at bluntly angular shoulder,

1.0 o.d. below rim, a comparatively greater width than in other species of genus. Bowl contracting evenly below shoulder, with straight sides, a segment of an inverted truncated cone of 25–42°, 0.72–0.75 (0.74) t.l. Aboral end squarely truncated, with slight convexity and diameter same as that of oral aperture. Wall thickest at nuchal level, thinning out at shoulder, and at aboral end. Animal filling 0.75 of lorica, with 2 small spherical macronuclei, each 7.5μ in diameter.

Five loricæ: L., total, 57–60 (58); neck, 10–12 (11.2); bowl, 46–48 (46.8); to shoulder, 21–24 (22); from shoulder to aboral end, 36. D., oral, 27–31 (29.4); shoulder, 45–50 (47.8); base, 24–30 (28.2)μ.

The question arises as to whether or not this species is based upon an artifact resulting from deformation. Angulation, except at the aboral end, is unusual among other genera of the Tintinnoinea. Its occurrence also in *pentagona*, *biangulata*, and *subangulata* suggests a susceptibility to such deformations. On the other hand, the considerable number of loricæ, 10 in *amphora*, 128 in *pentagona*, 5 in *biangulata*, 6 in *urna*, and 8 in *subangulata*, exhibit this angulation. Moreover, it occurs coincidentally in collections with non-angulated species, and it is difficult to correlate each angulated species with a non-angulated one having similar oral aperture, thickness of wall, proportions, and dimensions.

At 11 stations, viz., at 2, and 9, respectively, in Easter Island Eddy and Drift; at 69–76 (71.8)°; 18 loricæ.

Proplectella biangulata Kofoid and Campbell

Plate 23, fig. 7

Lorica with subcylindrical central region and conical ends; 1.90–2.44 (2.30) o.d., or 1.85 greatest diameter. Oral margin rounded, in section an angle of 35°. Oral region internally a truncated segment of a concave cone of 6–10°, 0.14–0.19 t.l. in length. Oral aperture 0.41–0.43 (0.42) t.l. in diameter. Inner collar clearly defined, with prominent rounded internal angle, thinning down to level of upper angle of bowl. Nuchal diameter 0.89 o.d. Bowl septangular in outline, with collar region not differentiated externally from bowl. Anterior section of lorica, including upper part of bowl, a truncated segment of a slightly concave cone of 50°, 0.24–0.28 t.l. in length, with basal diameter of 1.42–1.78 (1.60) o.d. Middle section subcylindrical, its diameter in some loricæ increasing slightly posteriorly, with sides slightly concave externally, 0.35–0.44 (0.37) t.l. Posterior segment an inverted cone of 85°, with flat or slightly outwardly convex sides, and a broadly to

narrowly rounded or even subacute antapex. Wall comparatively very thick, except near aboral end, thickest at base of inner collar, quite thick on lateral wall, thinning aborally to aboral end.

Four loricæ: L., total, 62–66 (63.2); neck, 10–12 (11); bowl, 51–54 (52.2); to first shoulder, 15–19 (17.2); to second shoulder, 40–44 (40.1). D., oral, 26–29 (27); greatest, 43–48 (45.7) μ.

At 5 stations, viz., at 1 and 4, respectively, in Easter Island Eddy and Drift; at 68–72 (71)°; 5 loricæ.

Proplectella claparèdei (Entz, Sr.) Kofoid and Campbell

Undella claparèdei, Alzamora, 1929, p. 8, fig. 15.

Lorica egg-shaped with narrower end broadly truncated; 1.42–1.86 (1.65) o.d., or 1.26 greatest diameter. Oral margin in section an angle of 25–30°. Oral aperture large, 0.54–0.70 (0.61) t.l. in diameter. Oral region internally everted, its cavity a segment of an inverted concave cone of 30–35°, 0.14–0.22 o.d. in length. Inner collar thickening from oral margin to about 5μ or 0.17–0.20 o.d., 0.17–0.20 t.l. in length, with nuchal diameter 0.78–0.93 (0.86) o.d. Bowl stout ovoidal, with greatest diameter, 1.13–1.48 (1.32) o.d., near middle of lorica. Aboral end hemispherical, prismatic. Wall with maximum thickness (0.17–0.20 o.d.) in throat, thinning gradually to minimum (0.07–0.04 o.d.) at aboral end.

Five loricæ: L., total, 41–61 (54); neck, 8–13 (10.4). D., oral, 27–37 (32.8); nuchal diameter, 25–37 (27.8); bowl, 37–46 (42.8); nuchal wall, 5μ.

At 62 stations, viz., at 1, 6, 17, 2, 8, 1, 4, and 23, respectively, in California, Mexican, Peruvian and South Equatorial currents, Panamic Area, Galapagos and Easter Island eddies, and Drift; at 65–85 (73.4)°; 147 loricæ.

Proplectella cuspidata Kofoid and Campbell

Plate 24, fig. 10

Lorica slender bullet-shaped, subcylindrical anteriorly, conical posteriorly; 2.20–2.60 (2.50) o.d. Oral margin abruptly sharp, in section an angle of 15°. Oral region slightly everted internally in an inverted concave cone 10–20°, 0.3 o.d. in length, external contour not modified. Oral aperture 0.21–0.27 (0.23) t.l. in diameter. Inner collar not sharply differentiated, its thickness increasing below oral margin, reducing nuchal diameter to 0.9 of oral, fading out aborally within

0.50–0.65 o.d. below oral margin. Bowl flaring but little, with greatest diameter, 1.0–1.1 (1.06) o.d., above middle of lorica, contracting distally in posterior 0.50–0.66 of bowl to inverted convex cone of 38–46°, concave in lower third. Aboral end sharp-pointed. Wall thickest at base of inner collar, thinnest in aboral region.

Seven loricæ: L., total, 80–92 (86.8). D., oral, 34–43 (36.3) μ.

At 8 stations, viz., at 2, 1, 2, 1, and 2, respectively, in Mexican and Peruvian currents, Panamic Area, Galapagos Eddy, and Drift; at 71–84 (76.9)°; 12 loricæ.

Proplectella ellipsoida Kofoid and Campbell

Plate 23, fig. 6; Plate 24, fig. 6

Lorica narrowly subellipsoidal, truncated anteriorly, and contracted posteriorly to a subacute antapex; 1.75–2.14 (1.95) o.d., or 1.4 times greatest diameter. Oral margin acute, in section an angle of 15–35°. Oral aperture 0.42–0.57 (0.51) t.l. in diameter. Oral region flaring internally in a segment of a slightly concave inverted cone of 35–40°. Neck not differentiated externally. Inner collar clearly differentiated internally by abrupt thinning down to wall of bowl; 0.12–0.16 (0.14) t.l. Nuchal diameter 0.85–1.00 (0.90) o.d. Bowl subellipsoidal, narrowing more posteriorly than anteriorly, reaching its greatest diameter (1.24–1.65 [1.37] o.d.) at 0.36–0.46 (0.42) t.l. below oral margin, tapering aborally within an inverted convex cone of 90–100° in a graceful convex contour to subacute antapex. Wall with maximum thickness at nuchal region and minimum at aboral end. Animal filling 0.6 of lorica, with 2 subspheroidal macronuclei, 7–10 μ in diameter.

Eleven loricæ: L., total, 59–66 (63); length of collar, 7–10 (9.1); to greatest diameter, 22–32 (27.4). D., oral, 26–37 (32); nuchal, 25–31 (26.3); bowl, 40–45 (44.6); nuchal wall, 3–5 μ.

At 23 stations, viz., at 2, 4, 1, and 16, respectively, in Peruvian Current, Easter Island and Galapagos eddies, and Drift; at 68–81 (72.7)°; 44 loricæ.

Proplectella fastigata (Jörgensen) Kofoid and Campbell

Plate 23, fig. 8

Lorica very stout ovoidal with very thick wall, narrow aperture, and hemispherical aboral end; 1.94–2.07 (1.96) o.d., or about 1.15 times greatest diameter. Oral margin in section a wide angle, 45–50°. Oral

aperture relatively narrow, 0.47–0.52 (0.51) t.l. in diameter. Inner collar sharp-angled at nuchal constriction and straight-walled above; merging very gradually below angle into bowl; its length to rounded shoulder 0.18–0.20 (0.19) t.l. Nuchal diameter 0.89–0.94 (0.92) o.d. Bowl expanding below oral margin in an inverted cone of 85°, attaining greatest diameter (1.65–1.82 [1.72] o.d.) at 0.31–0.38 (0.33) t.l. below oral margin, somewhat flattened laterally below shoulder, with pronounced change in curvature at level of greatest expansion, forming a smoothly rounded, prominent shoulder, posteriorly narrowing gradually, with convex lateral wall more or less flattened to 1.5 o.d. below oral margin. Aboral end broadly rounded, hemispherical, or with its contour postero-laterally not quite filling out a hemisphere, with faint postero-lateral angle in loricæ with more flattened lateral wall. Wall heavy, enclosing a prismatic layer (Brandt, pl. 64, fig. 11a), reaching maximum thickness at nuchal region, thinning from level of greatest diameter to aboral end.

Four loricæ: L., total, 69–75 (72.0); neck, 9–11 (10.3); to greatest diameter, 21–25 (22.6). D., oral, 35–39 (37); nuchal diameter, 32–36 (33.5); bowl, 61–64 (62.7); nuchal wall, 7.5–9 μ.

At 4 stations, 2 each in California and Mexican currents; at 71–84 (78.5)°; 7 loricæ.

Proplectella globosa (Brandt) Kofoid and Campbell

Lorica broadly truncated ovoidal or pot-shaped; 1.40–1.78 (1.53) o.d., or 1.15 greatest diameter. Oral margin sharp-angled (15–28°). Oral region flaring internally in segment of inverted concave cone 15–20°, 0.2 t.l. in length. Oral aperture 0.59–0.70 (0.65) t.l. in diameter. Inner collar well developed, with outer surface typically convex, but sometimes flattened or slightly concave. Nuchal diameter 0.83–0.96 (0.86) o.d. Upper lorica, including collar, externally a segment of a cone 15–22°, 0.27–0.33 t.l. Bowl expanding gradually, attaining its greatest diameter (1.21–1.60 [1.34] o.d.) at 0.42–0.63 (0.49) t.l. below oral margin. Aboral region rotund, extending a trifle beyond contour of a hemisphere, in few loricæ with trace of aboral angulation. Wall thickest at base of collar, thinning evenly to aboral end. Animal very large, filling 0.7 of lorica, with 2 macronuclei, 4 by 13 μ, and 12 membranelles on one side.

Ten loricæ: L., total, 37–58 (46.2); neck, 6–10 (7.6); bowl, 31–48 (38.4). D., oral, 27–34 (30.3); greatest, 33–51 (40) μ.

At 20 stations, viz., at 1, 1, 2, 3, 1, and 12, respectively, in California, Mexican, and Peruvian currents, Panamic Area, Galapagos Eddy, and Drift; at 67–85 (74.4)°; 46 loricæ.

Proplectella ostenfeldi Kofoid and Campbell

Plate 23, fig. 3

Lorica cylindrical in its anterior 0.66 and pointed hemispheroidal aborally; 1.42–1.95 (1.73) o.d., or 1.45 times greatest diameter. Oral margin in section an angle of 10°. Oral region flaring internally in a segment of an inverted concave cone 12–15°, 0.18–0.26 (0.22) t.l. Oral aperture 0.54–0.70 (0.57) t.l. in diameter. Inner collar never angular, broadly rounded, feebly developed, thinning down to normal wall within 0.50–0.75 o.d. Nuchal diameter 0.81–0.94 (0.89) o.d. Upper part of lorica, including collar, outwardly slightly concave and nearly subcylindrical for 0.3–0.4 t.l. Bowl expanding posteriorly, reaching to its greatest diameter (1.02–1.37 [1.20] o.d.) 0.43–0.55 (0.48) t.l. from oral margin. Aboral end broad, contracting laterally above within contour of a hemisphere but tapering distally to a blunt tip in a convex cone (90°), with slight concavity above tip in several loricæ. Wall with maximum thickness at base of inner collar and minimum at aboral end. Differs from *Undella ostenfeldi* in presence of inner collar.

Twelve loricæ: L., total, 43–55 (48.7); collar, 8–14 (10.9). D., oral, 23–34 (27.7); collar, 20–28 (24.4); greatest, 30–41 (34.1) μ.

At 16 stations, viz., at 1, 1, 2, 1, and 11, respectively, in Peruvian and South Equatorial currents, Galapagos and Easter Island eddies, and Drift; at 72–81 (75.9)°; 23 loricæ.

Proplectella ovata (Jörgensen) Kofoid and Campbell

Plate 23, fig. 9

Lorica very broad truncated ovoidal, with very short neck, hemispherical aboral end, and heavy wall; 1.55–1.67 (1.58) o.d., or 1.2 greatest diameter. Oral margin in section an angle of 30°. Oral aperture 0.52–0.54 (0.53) t.l. in diameter. Oral region flaring internally in a segment of a concave inverted cone of 22–35°. Neck outwardly very short, 0.25 o.d. in length, forming a segment of a slightly concave cone 10–15°. Inner collar well thickened but not sharply separated from bowl by definite shoulder, 0.17–0.27 (0.22) t.l. in length, with nuchal diameter 0.80–0.97 (0.86) o.d. Bowl broadly ovoidal, 1.35 o.d. in length; its greatest diameter 1.26–1.40 (1.32) o.d., at 0.39–0.53 (0.48)

t.l. from oral margin. Aboral end broadly rounded, almost hemispherical, in a few loricæ with a tendency to become bluntly pointed, but not so definitely as in *tenuis*. Wall comparatively very thick, with thickening extending well down sides of bowl, with maximum thickness in nuchal region, gradually decreasing laterally to minimum in aboral end.

Nine loricæ: L., total, 61–69 (63.7); neck, 8–14 (11.1); bowl, 49–54 (52.6). D., oral, 35–41 (39.2); nuchal, 30–33 (31.5); bowl, 47–63 (51.1) μ.

At 20 stations, viz., at 2, 4, 1, 1, 3, and 9, respectively, in Mexican, Peruvian, South Equatorial, and North Equatorial currents, Panamic Area, and Drift; at 68–84 (74.6)°; 41 loricæ.

Proplectella parva Kofoid and Campbell

Plate 24, figs. 3, 12

Lorica tapering bullet-shaped, subcylindrical anteriorly and relatively narrow conical (60°) posteriorly, with a conical aboral end; 1.63–2.49 (2.14) o.d., or nearly twice greatest diameter. Oral margin thinned down in section to an acute angle (20–33°). Oral region flaring internally in a segment of an inverted, deeply concave cone of 32–35°, 0.15 t.l. Oral aperture 0.41–0.59 (0.49) t.l. in diameter. Inner collar not angled internally, thinning down gradually to normal wall at middle of lorica. Nuchal diameter 0.80–0.83 o.d. Lorica, including collar, subconical (up to 15°) anteriorly, with slight outer convexity or even a slight concavity above level of nuchal constriction. Bowl with greatest diameter, 1.07–1.23 (1.12) o.d., at 0.45–0.60 (0.55) t.l. from oral margin. Aboral region contracting in a cone 45–65°, convex in its upper half and straight below. Aboral end always sharply pointed. Wall thickest at base of inner collar, thinning out gradually to aboral end. Outer surface of several loricæ covered by scattered coccoliths of *Syracosphæra spinosa* (?), about 1 μ in length. Another lorica had Calyptrosphæra (?) (3 by 6 μ) agglomerated on surface. Animal large, filling 0.7–0.8 of lorica, with a large, centrally located, dense macronucleus 9 by 13 μ.

Eight loricæ: L. total, 44–63 (54.2). D., oral, 25–27 (26.4); greatest, 28–33 (29.7) μ.

At 38 stations, viz., at 3, 7, 1, 1, 1, 4, 2, 2, and 17, respectively, in California, Peruvian, South Equatorial, Equatorial Counter, and North Equatorial currents, Panamic Area, Easter Island and Galapagos eddies, and Drift; at 66–81 (74)°; 71 loricæ.

Proplectella pentagona (Jörgensen) Kofoid and Campbell

Plate 23, figs. 10, 11

Lorica pentagonal, truncate pyriform, wide-angled aborally; 1.58–1.96 (1.68) o.d., or 1.15 greatest diameter. Oral margin thin, sharp-angled (35°). Oral region everted, internally a truncated segment of an inverted concave cone of 20–30°, 0.11–0.18 (0.16) t.l. Oral aperture 0.51–0.60 (0.57) t.l. in diameter. Inner collar well developed, with rounded inner angle, or expanding asymmetrically in rounded elevation on each face, contracting to normal thickness midway between rim and angular expansion of bowl, or (Plate 23, fig. 11) bulging locally. Nuchal diameter 0.86–1.00 (0.95) o.d. Bowl from oral margin to widest part a truncated segment of a cone 30–35°, 0.6 t. l., with straight lateral outlines, its greatest diameter, 1.34–1.44 (1.43) o.d., at 0.54–0.60 (0.58) t.l. below oral margin, whose wall in section is an externally rounded angle of 120–130°, contracting sharply below in an inverted, slightly concave aboral cone of 90°, 0.4 t.l. in length, with bluntly rounded to subacute aboral end. Wall thickest at nuchal level, thinning out evenly to aboral end.

Seven loricæ: L., total, 47–66 (52.6); collar, 7–12 (9); bowl, 40–47 (43.6); nuchal level to shoulder, 27–33 (30.9); from shoulder to aboral end, 19–26 (21.7). D., oral, 29–34 (32.2); greatest, 40–55 (45.6) μ.

At 19 stations, viz., at 2, 1, and 16, respectively, in Peruvian Current, Galapagos Eddy, and Drift; at 66–81 (74.5)°; 128 loricæ.

Proplectella perpusilla Kofoid and Campbell

Plate 24, figs. 1, 2

Lorica stout ovoidal with a short neck; 1.42–1.95 (1.73) o.d., or 1.37 greatest diameter. Oral aperture 0.56–0.59 (0.57) t.l. in diameter. Oral region flaring above neck both internally and externally, forming segments of inverted cones of 7–12° and 18–20°, respectively. Inner collar feebly developed, not sharply delimited from bowl. Neck 0.19–0.25 (0.22) t.l. in length, with internal diameter 0.84–0.90 (0.87) o.d., but externally only half this length with diameter little, if any, less than oral. Bowl proper broadly ovoidal to ellipsoidal in about the proportions of a hen's egg, expanding posteriorly below neck, reaching its greatest diameter, 1.10–1.40 (1.26) o.d., near middle or below it at 0.42–0.70 (0.56) t.l. from oral margin. Aboral end broadly rounded or slightly flattened. Wall with maximum thickness in collar, thinning out below, reaching minimum thickness near aboral end.

Eight loricæ: L., total, 41–50 (47); neck, 8–12 (10.1); to greatest diameter, 20–32 (27.7). D., oral, 25–28 (27.0); neck, 21–26 (23.8); bowl, 30–40 (33.9) μ.

At 60 stations, viz., at 2, 5, 15, 8, 4, 2, and 24, respectively, in California, Mexican, and Peruvian currents, Panamic Area, Easter Island and Galapagos eddies, and Drift; at 65–85 (73.3)°; 205 loricæ.

Proplectella prælonga Kofoid and Campbell

Plate 23, figs. 2, 12

Lorica slender, truncate ovoidal, with no delimited anterior extension; 1.00–2.59 (2.02) o.d., or about 1.46 greatest diameter. Oral aperture only moderately wide, 0.45–0.46 (0.45) t.l. in diameter. Oral rim narrow-angled (20–25°). Oral region internally gradually everted in a short segment of an inverted cone (20–35°) with concave sides. Suboral region outwardly included within a segment of a cone 15–35°, with flat or slightly concave sides, 0.25–0.33 o.d. in length. Suboral thickening greatest at nuchal level; thinning out gradually to normal wall of bowl below neck within 0.33–0.66 o.d., in extreme cases reaching equator of bowl. Nuchal opening at 0.17–0.21 (0.19) t.l. below oral margin, with least diameter 0.60–0.87 (0.80) o.d. Bowl below nuchal region a smoothly rounded ovoid with greatest diameter 1.15–1.76 (1.38) o.d. near middle of lorica, 0.50–0.57 (0.53) t.l. below oral margin. Aboral end broadly rounded, hemispherical, or more narrowly rounded and longer than a hemisphere. Wall thick, reaching its maximum thickness at nuchal level, attaining its minimum near aboral end. In one lorica the cytosome filled 0.6 of the cavity and had 4 ovoidal macronuclei, each 7 by 12 μ.

Ten loricæ: L., total, 56–76 (63); collar or nuchal region, 10–13 (11.9); to greatest diameter of bowl, 27–43 (33.4). D., oral, 27–35 (33); nuchal, 23–30 (26.6); greatest, 38–47 (43.5) μ.

At 14 stations, viz., at 10, 1, and 3, respectively, in Peruvian Current, Panamic Area, and Drift; at 66–80 (70)°: 23 loricæ.

Proplectella subangulata Kofoid and Campbell

Plate 23, fig. 5

Lorica with truncated, stout ovoidal contour, somewhat angled at two levels of bowl, 1.62–1.95 (1.83) o.d., or 1.26 greatest diameter. Oral margin abruptly contracted to a sharp edge, in section an angle

of 35°. Oral region internally abruptly flared for 0.12 o.d., a segment of an inverted concave cone of 37°. Oral aperture 0.51–0.62 (0.61) t.l. in diameter. Inner collar slightly developed, externally not differentiated, not angled internally, only slightly thickened, with convex inner face, gradually merging into wall of bowl, continuing with a slight decrease in thickness for 0.22–0.32 (0.28) t.l. to upper shoulder; 0.13–0.14 (0.13) t.l. in length. Nuchal diameter 0.85–0.94 (0.90) o.d. Lorica as a whole consisting of three sections; uppermost, including collar, a segment of a concave cone 25–30°, forming 0.3 t.l., its base forming upper shoulder of lorica, its most prominent angle, and its greatest diameter (1.17–1.31 [1.24] o.d.), though in some loricæ this is on bulge below shoulder; middle section with sides of bowl flattened and only slightly convex, tapering aborally, a segment of an inverted convex cone of 12–30°, forming 0.45–0.50 t.l.; terminal segment an inverted convex cone of 90°, with subacute antapex. Lower shoulder, but weakly developed in two of four loricæ, with a diameter of 0.81–0.86 (0.83) o.d. at 0.79–0.83 (0.80) t.l. below oral margin. Wall with maximum thickness at base of collar, and minimum at aboral end.

Five loricæ: L., total, 58–63 (59.7); collar, 7–9 (7.6); to anterior shoulder, 15–18 (16); to posterior shoulder, 47; to greatest diameter, 15–28 (20.5). D., oral, 32–36 (33.8); anterior shoulder, 37–44 (41.7); posterior shoulder, 26–28 (27.4); greatest, 40–44 (42.4) μ.

At 5 stations, viz., at 2, 1, and 2, respectively, in California Current, Galapagos Eddy, and Drift; at 69–81 (74)°; 8 loricæ.

Proplectella tenuis Kofoid and Campbell

Plate 23, fig. 4

Lorica truncated subellipsoidal in contour, with blunt, scarcely pointed aboral end; 1.67–2.33 (1.85) o.d., or about 1.42 greatest diameter. Oral margin in section sharp-angled (30–37°). Oral region flaring internally in a segment of an inverted concave cone 18–22°. Oral aperture 0.49–0.60 (0.57) t.l. in diameter. Nuchal region convex externally, rarely slightly, and for a short distance, concave. Inner collar well developed, blending aborally with wall of bowl rather abruptly at 0.5 o.d. below oral rim, its greatest thickness 0.14–0.19 (0.16) o.d., its length 0.15–0.21 (0.18) t.l. Nuchal diameter 0.84–0.88 (0.87) o.d. Bowl ellipsoidal for 0.6 t.l., its greatest diameter, 1.21–1.38 (1.28) o.d., either in midregion or anterior to it, 0.31–0.53 (0.45) t.l. below oral margin. At 0.72–0.82 (0.76) t.l. below oral margin, at a

diameter of 1.11–1.38 (1.27) o.d., curvature changes to very convex subconical contour contained within 90–100°. Aboral end rounded, but with less convexity than a hemisphere, contracting to a broadly blunt antapex. Wall with maximum thickness at nuchal level and minimum at aboral end, the two lamellæ sometimes meeting both laterally and aborally. Animal filling 0.5 of cavity of bowl.

Five loricæ: L., total, 63–70 (67); neck, 10–12 (11.2); bowl, 52–60 (55.7). D., oral, 33–41 (37.7); nuchal, 26–33 (30); bowl, 45–49 (47)μ.

At 12 stations, viz., at 1, 1, 1, 1, and 8, respectively, in California and Peruvian currents, Panamic Area, Easter Island Eddy, and Drift; at 69–83 (77.1)°; 20 loricæ.

Proplectella tumida Kofoid and Campbell

Plate 24, fig. 4

Lorica elongate ovate, with short, subcylindrical neck, 2 o.d., or 1.45 greatest diameter. Oral aperture relatively small, 0.6 diameter of bowl, or 0.38 t.l. Oral region everted internally, forming an inverted cone of 25° for 0.12 o.d. below oral margin; externally, for an equal distance, subcylindrical and slightly concave laterally. At its base inner collar contracting at 0.08 t.l. to nuchal diameter of 0.85 o.d. Suboral thickening fading out gradually below nuchal constriction. Bowl expanding into an elongated ovoidal form, with greatest diameter (1.65 o.d.) at 1.76 o.d., or 0.53 t.l. below oral margin. Aboral region rounded, its contour a little less than a hemisphere. Wall thickest at base of collar and thinnest at aboral end.

L., total, 61; collar, 5. D., oral, 24; greatest, 42μ.

At Sta. 4706, in Drift; at 72°; 1 lorica.

Proplectella urna Kofoid and Campbell

Plate 33, fig. 1

Lorica slender, ellipsoidal, seed-shaped, with pointed antapex; 4.4 o.d., or 1.79 greatest diameter. Oral margin sharp, in section an angle of 27°. Suboral region subcylindrical. Oral aperture small, 0.22 t.l. in diameter. Inner collar undeveloped, not angled internally, fading into normal wall within 1.0 o.d. of oral margin with only slight internal convexity. Nuchal diameter a trifle less than oral, its inner walls straight, subvertical, its length 0.12 t.l. Bowl elongated ellipsoidal, with greatest diameter, 2.46 o.d., at 0.44 t.l. below oral margin. An-

teriorly and externally lorica a truncated cone of 50° merging posteriorly into convex middle region of bowl and aborally contracting in inverted convex cone of 90°, with subacute antapex. Wall thickest in collar, tapering to aboral end.

L., total, 46; collar, 6. D., oral, 10; greatest 25μ.

At 6 stations, viz., at 1 and 5, respectively, in Easter Island Eddy and Drift; at 72–81 (75)°; 6 loricæ.

28. UNDELLA Daday emended Kofoid and Campbell

Undellidæ with bowl-shaped, but more often elongated tubular lorica; suboral region in optical section tapering to very thin oral margin, never with suboral ledge or inner collar; never divided into bowl and anterior cylinder, except in *californiensis;* never greatly or abruptly expanded aborally; rings absent; aboral end rounded, angular, pointed, or flattened; wall trilaminate, never reticulate or with distinct prismatic structure. Type species *Undella hyalina* Daday (1887b, pl. 18, fig. 17) from off Naples, with page priority.

Resembles Proplectella in general form and structure of wall more closely than any other genus. Differs from it in complete lack of inner collar and prevalence of elongation, which is lacking only in *turgida* and *hemispherica,* but appears only in *parva* series in Proplectella. Very similar to the simpler species of Parundella, such as *minor* and *grandis,* in size, proportions, and pattern of wall, so much so that their generic separation is in some species somewhat arbitrary. The decisive feature which places these two species in Parundella rather than Undella is the tapering aboral end widely prevalent in Parundella, a feature wholly lacking in Undella.

Established by Daday (1887b), who included in it three old and three new species, as follows: — *U. dohrnii, claparèdei* (included in Tintinnus by Entz, Jr.), *hyalina, lachmanni, spiralis* (described as Tintinnus by Fol), and *anadyomene* (described as Tintinnus by Entz, Sr.). Brandt (1907) emended Undella by clarifying the structure of the wall and by removing *U. spiralis* to *Rhabdonella spiralis* and *U. anadyomene* to *Tintinnus anadyomene.* The latter species is apparently unidentifiable, although we place it in Rhabdonella. He also added varieties *a* (= *U. attenuata* Jörg.), *b* (= *U. declivis* K. and C.), and *c* (= *U. dilatata* K. and C.) to *U. hyalina;* described as new *U. marsupialis* (transferred to Undellopsis by us [1929]), *U. collaria* (transferred to Amplectella by us) with var. *a* (= *Amplectella ampla* K. and C.), var.

b insignis (transferred to Amplectella by us), and var. *c* (= *Undellopsis bicollaria* K. and C.), and *U. tridivisa* (transferred to Cricundella by us); reduced *Undella subacuta* Cleve (1901a) (transferred by us to Proplectella) and *U. dohrnii* Daday (1887b) to varieties *a* and *b* of *U. claparèdei* (transferred by us to Proplectella); added to *U. claparèdei* var. *c* (= *Proplectella tenuis* K. and C.), var. *d* (included by us in *Proplectella subaeuta* [Cleve]), var. *e globosa* (transferred by us to Proplectella), var. *f* (= *Proplectella fastigata* [Jörg.] K. and C.), var. *g* (= *Proplectella ovata* [Jörg.] K. and C.); included *U. lachmanni* (transferred by us to Parundella) with var. *a* = (var. *grandis* Laackmann [1909] = *Proplectella grandis* [Laack.] K. and C.) and var. *b caudata* Ostenfeld (1899a) (= *Parundella caudata* [Ost.] K. and C.); described as new *U. messinensis* (= *Parundella messinensis* [Bdt.] Jörg.), and its var. *a* (= *Parundella attenuata* K. and C.); included *U. heros* Cleve (transferred by us to Xystonellopsis) with var. *a krämeri* and var. *b dahli* (transferred by us as species to Xystonellopsis), and var. *c*, which Laackmann (1909) made var. *brandti* and Jörgensen (1924) transferred to Xystonellopsis as a species; and described as new *U. armata* and *U. tenuirostris*, which we transferred to Xystonellopsis. Laackmann (1909) added one new species, *U. hemispherica.*

Jörgensen (1924) separated Undella into two subgenera, of which one, Parundella, we (1929) raised to generic rank and placed in the Xystonellidæ. Jörgensen's concept of Undella was a wide one. We (1929) separated from it not only the genus Parundella, in which he had included *U. caudata* (*sensu lato*), *U. aculeata* and its forma *longa* (= *Parundella longa* [Jörg.] K. and C.), *U. lohmanni* (*sensu lato*), and *U. messinensis*, but also species which we (1929) segregated into other genera. Into Undellopsis we placed his *U. marsupialis* and its var. *subangulata*, and also his *U. tricollaria* (as species), and into Amplectella his *U. collaria.*

In 1929 we separated the rather discordant group of species which Brandt (1906, 1907) and Jörgensen (1924) had assembled in Undella, into Undella (*sensu stricto*) without rings, inner collar, or ledge, Parundella with tapering aboral region and no inner collar, Proplectella with inner collar, Amplectella with rings on cylinder but no ledge, Amplectellopsis with no rings on cylinder, and Undellopsis with a suboral ledge. Parundella was placed by us in the Xystonellidæ, and the remaining genera in the new family Undellidæ.

Contains 19 species, of which 14 occur in Expedition material, 10 of which were new (1929); 3, *media*, *mammilata* and *minuta*, are described in this Report, and 15 are included in this Report. One species, *U.*

pusilla Paulsen (1904, p. 25) is a nomen nudum, leaving 18 valid species. Subdivided into three series as follows: — the *ostenfeldi* series, including *ostenfeldi, mammilata, clevei, dilatata,* and *hyalina;* the *hyalinella* series, including *hyalinella, media, declivis, parva, attenuata,* and *peruana;* and the *turgida* series, including *turgida, hemispherica, californiensis, pistillum, dohrnii,* and *bulla.*

U. minuta sp. nov. (Plate 24, fig. 5) is the starting point for the *ostenfeldi* and *hyalinella* series. (cf footnote on p. 263).

Undella bulla Kofoid and Campbell

Plate 24, fig. 21

Lorica elongated cylindrical with a pestle-shaped aboral region; 2.92–3.90 (3.12) o.d. Oral margin thin, narrowly rounded. Oral rim typically developed, with concave outer slope and convex inner one, in section an angle of 18°. Oral region sometimes contracting in a segment of a truncated cone of not over 15°, 0.22–0.25 o.d. in length. Oral diameter 0.31 t.l. Bowl consisting of anterior cylinder and terminal knob. Cylinder decreasing evenly and very slightly from an anterior diameter of 1.06–1.36 (1.17) o.d. for 0.6 t.l., then contracting suddenly, forming an inverted segment of a cone of 27° with a length of 0.25 t.l. Cylindrical section followed by a gradual constriction, or concavity, in aboral third to 0.85–1.00 (0.92) o.d., deepest at 0.66 o.d. from aboral end. Aboral end saccular, 0.15 t.l. in length, usually slightly convexly expanded from constriction, and rounding off in depressed aboral end, 0.7–0.9 o.d. in diameter. Wall uniform in thickness, thickening below oral margin in a sigmoid curve and thinning at deformable aboral end.

Four loricæ: L., total, 146–265 (179). D., oral, 45–70 (57.5); suboral ledge, 55–77 (62); constriction, 40–50 (46) μ.

At 5 stations, viz., at 2 and 3, respectively, in California Current and Easter Island Eddy; at 69–75 (72.6)°; 5 loricæ.

Undella californiensis Kofoid and Campbell

Plate 24, fig. 15

Lorica small, shaped like a rather inflated bulb of an electric lamp; 2.42 o.d. or 1.53 its greatest diameter; readily divisible into an anterior cone and bowl. Oral margin acute, in section an angle of 25° with outer slope more convex than inner, 0.2 o.d. in length. No differentiated oral rim or suboral thickening. Oral aperture 0.24 t.l. in diameter. Oral region slightly flaring. Lorica with anterior conical segment merging

into bowl. Anterior region 0.34 t.l. in length, concave subconical (20°) in contour, with posterior diameter of 1.5 o.d. Bowl depressed subspheroidal in form, with vertical length (0.76 t.l.) 0.64 its equatorial diameter, and greatest diameter (2.05 o.d.) in midplane of bowl. Aboral region depressed hemispheroidal. Wall with maximum thickness in middle of anterior cylinder, and minimum in aboral end. Animal with 2 macronuclei and 2 micronuclei.

L., total, 107. D., oral, 45; greatest, 70μ.

Recorded at the type locality, "Albatross" Sta. 4847 in California Current off Point Conception at 36° 41′ N., 132° 26′ E., at 76°; 1 lorica.

Undella declivis Kofoid and Campbell

U. hyalina Übergangsformen zur var. *b*, Laackmann, 1909, p. 469.
U. dohrni, Alzamora, 1929, pp. 7–8, fig. 16.

Lorica stout, tubular, with a subangular aboral region; 2.50–2.98 (2.72) o.d. Oral margin narrowly rounded, thinning within 0.12–0.16 o.d., with concave to sigmoid outer face and convex, concave, or vertical inner one. Oral region flaring up to 15° or contracting up to 12°. Oral diameter 0.36–0.40 t.l. Bowl subcylindrical, with upper diameter of 1.02–1.09 (1.07) o.d., and increasing to 1.04–1.12 (1.09) at greatest diameter near middle of lorica; with upper subcylindrical part 0.62–0.73 (0.71) t.l. from oral margin to shoulder of conical intermediate segment below, contracting below shoulder into a truncated and inverted cone of 9–23°, with outwardly concave sides and a length of 0.20–0.25 (0.23) t.l., with an anterior diameter of 0.64–0.87 (0.76) o.d. Aboral region an inverted cone of 108–129°, with convex sides. Tip rounded or pointed. Wall thin laterally, thickening in lower part of intermediate cone and thinning near tip. Animal large, occupying from 0.4 to 0.8 of lorica, with 2 oval macronuclei, each 10 by 12μ. One individual showed a new lateral peristome and had a number of large vacuoles.

Eight loricæ: L., total, 123–153 (141.2). D., oral, 49–55 (51.7)μ. Brandt's loricæ (pl. 63, figs. 4–6) are 143–148 and 55–70μ, the relatively greater diameter suggesting flattening.

Jörgensen's Mediterranean material may belong here in part, although the lengths given (180–255μ) are all much greater than those typical of the species; but correlation of length with temperature may play a role in this situation.

At 19 stations, viz., at 1, 1, 5, and 12, respectively, in California and South Equatorial currents, Easter Island Eddy, and Drift; at 68–81 (74.1)°; 49 loricæ.

Undella dilatata Kofoid and Campbell

U. dilatata, partim, K. and C., 1929, p. 262, fig. 499 (see also *U. minuta*).

Lorica sack-shaped, with slightly enlarged, sometimes faintly angulate, or terminally mammilate aboral end, with wall thickened in swollen region; 2.58–3.24 (2.76) o.d. Oral margin narrowly rounded, with outward slope concave (18°) for 0.1–0.2 o.d. Oral region with no, or but little flare. Lorica below rim 1.02–1.15 o.d. in diameter, continuing for 0.6–0.7 t.l., then bulging with slightest trace of a subangular contour in some loricæ below this level with a conical (11–16°) expansion, only 0.1 o.d. in length, merging with expanded aboral end. Aboral end hemispherical to subconical, a wide inverted cone (118–125°), with sides often becoming straight distally; sometimes pointed, but never prolonged, in some loricæ faintly mammilate. Wall thick in cylinder, thickest in swollen aboral region, thinning evenly in aboral end to nearly thickness of the two lamellæ. Cytosome filling from 0.4 to 0.7 of cavity, with 2 large oval macronuclei, 15 by 18 μ, and 2 oval micronuclei, 5 by 7 μ (premitotic ?), and 20 membranelles.

Five loricæ: L., total, 134–162 (143.2). D., oral, 50–52 (51.8); greatest, 60–67 (63) μ.

At 12 stations, viz., at 1, 1, 1, and 9, respectively, in California and Mexican currents, Galapagos Eddy, and Drift; at 68–83 (73.5)°; 27 loricæ.

Undella hemispherica Laackmann

Plate 24, fig. 17

Lorica short, wide, broadly pointed bowl-shaped; 1.06–1.95 (1.39) o.d. Oral margin sharp, abruptly acute. Oral rim not clearly defined, triangular (35°) in section, with its outer surface flat, and inner slightly convex, 0.14 t.l., with or without slight constriction below. Oral cavity flaring slightly (15°) for a short distance. Bowl below rim smoothly rounded or in absence of suboral constriction subhemispherical in contour, its greatest diameter slightly above middle not exceeding 1.25 o.d. Aboral end more or less broadly rounded or slightly contracted in a very convex inverted cone of 90–100°, more or less subhemispherical. Tip bluntly rounded, with a short apical projection of inner lamella only toward outer one. Wall with prisms in 2 or 3 layers; relatively thick throughout, its maximum thickness in base of oral rim, thinning aborally below equator, thinnest in apical projection of inner lamella. Naviculoid diatoms sometimes adherent to outer surface, and a sparse incrustation of minute ovoidal coccoliths

of Pontosphæra not infrequent. Animal moderately large, filling over 0.5 of lorica, with 2 oval macronuclei, each 5 by 8 μ, and 2 spherical micronuclei, each 3 μ in diameter.

Ten loricæ: L., total, 61–67 (64.2). D., oral, 42–48 (45.7); greatest, 54–63 (59.6) μ.

Oral aperture in our loricæ 34–55 μ, but in Laackmann's figure 62 μ.

At 29 stations, viz., at 3, 4, 1, 3, and 18, respectively, in California, Mexican, and Equatorial Counter currents, Panamic Area, and Drift; at 68–85 (79.7)°; 67 loricæ.

Undella hyalina Daday

Lorica shaped like a pointed finger cot, quite elongated cylindrical, except for blunt subangular aboral end; 2.9–3.9 (3.4) o.d. Oral margin narrowly rounded, thinning out for 0.16–0.25 o.d., with convex or concave outer slope and inner face in section an angle of 13–18°. Oral region not flaring. Bowl continuing as a cylinder, 0.7 t.l. in diameter, contracting immediately below as an outwardly convex cone, becoming 93–110° distally. Aboral end bluntly pointed. Wall thin, uniform inner and outer lamellæ enclosing a homogeneous non-prismatic intermediate layer; expanding uniformly from oral margin to cylinder, thinning out again in aboral cone to aboral end. Daday (1887b, pl. 18, fig. 17) records 2 small oval macronuclei, 2 micronuclei, and 20 membranelles.

Three loricæ: L., total, 174–190. D., oral, 55–60; greatest, 60–70 μ. One lorica from Naples, collected by the senior author in winter of 1908 was 227, 53, and 62 μ.

Our figure (1929, fig. 511) is a copy of Daday's (1887b, pl. 18, fig. 17). The magnification of this figure is in obvious error. Daday states in the explanation of his plates that it is "Oc. 3, Syst. 3" which gives approximately X214. On this basis the figured lorica has a length of 329 μ, but in text he (p. 564) states that the length is 225–243 μ. At the alternative magnification, "Oc. 3, Syst. 5", used by him in some other figures on his plates, the magnification is X673 which makes length of the lorica in his figure 154 μ. This length (154 μ) is too small and 329 μ is plainly too large. We therefore use Daday's maximum length (243 μ) as stated in text for the dimensions of the type used in our figure (1929, fig. 511).

At 20 stations, viz., at 3, 1, 2, 1, and 13, respectively, in California, Mexican, and Peruvian currents, Galapagos Eddy, and Drift; at 65–83 (75.4)°; 72 loricæ.

Undella hyalinella Kofoid and Campbell

Plate 24, fig. 14

Lorica diminutive, elongated, vase-shaped, with slight but broad suboral constriction, aboral expansion, and tendency to aboral angulation; 2.6–3.2 (2.9) o.d. Oral margin narrowly rounded, with vertical inner face and slightly convex outer. Oral region flaring (12–18°) for an oral diameter or 0.20–0.25 t.l. below oral margin, a broad zone of constriction external to maximum of 1 o.d. at 1 o.d. below oral margin, extending over anterior 0.5 of lorica. Due to increasing but slight suboral thickening, lumen constricted at this level to 0.80–0.93 (0.87) o.d. Bowl increasing in diameter from constricted region evenly to greatest diameter (1.1–1.2 o.d.) at 0.55–1.00 (0.70) t.l. from oral margin. Aboral region angular. Bowl convex below, contracting at 0.8 o.d. from aboral end in short (0.5 o.d.) segment of an inverted cone of 15–25°, sometimes with (Plate 24, fig. 9), slight bulge near posterior end and always slightly rounded. Aboral region a wider and shorter cone than the one above it, 0.10–0.20 (0.15) t.l., an inverted cone of 75–88°, with outwardly convex sides. Tip either pointed or moderately rounded. Wall comparatively thick, thickest near base of suboral funnel, thinning out above to oral margin and below, beyond middle of bowl, thickening again to an unusual degree in aboral cone.

Three loricæ: L., total, 76–88. D., oral 24–28; greatest, 26–27 μ.

At Sta. 4571, in California Current; at 71°; 3 loricæ.

Undella mammilata spec. nov.

Plate 24, figs. 11, 13

Lorica cylindrical tube-shaped, with broadly rounded, mammilate aboral end; 3.76–4.11 o.d. in length. Oral margin narrowly rounded, thinning down within 0.16 o.d. of edge, with concave or convex outer and subvertical inner face, in section an angle of 15°. Oral region contracting towards margin within a cone of not over 12°. Oral diameter 0.25–0.27 t.l. Lorica below oral rim subcylindrical for 0.87–0.89 t.l., slightly convex outwardly, widest (1.1 o.d.) near middle, contracting in distal 0.16 in a rounded aboral region with hemispherical (or less) contour with a central boss 0.35–0.40 o.d. in basal diameter and 0.35 in length, forming a low inverted dome flattened aborally. Wall with very thin inner and outer lamellæ, enclosing a homogeneous, nonprismatic intermediate layer, of nearly uniform thickness from oral rim to base of aboral boss; thinning gradually in boss.

Two loricæ: L., total, 178–203; boss, 4. D., oral, 49–51; greatest, 52–55; base of boss, 8–12 μ.

At 2 stations, viz., at Sta. 4574 in California Current and 4678 in Peruvian Current; at 68–69°; 2 loricæ.

Undella media spec. nov.

Plate 24, figs. 7, 9

U. hyalina var. *a, partim*, Brandt, 1906, p. 30, pl. 63, fig. 3 (for pl. 63, figs. 1–2, see *U. parva*).

U. parva, partim, K. and C., 1929, p. 264 (for p. 264 in part and fig. 508, see *U. parva*).

Lorica fairly stout, elongate thimble-shaped, with blunt-pointed, subangular, slightly enlarged aboral region; 2.40–3.00 (2.83) o.d. Oral margin thin, rounded, with outwardly concave slope (15° from vertical axis) for not over 0.12–0.15 o.d., reaching a diameter of 1.13–1.27 o.d., and inner vertical face. Brandt (pl. 63, fig. 3) shows inner concave and outer vertical faces. Cylindrical upper part of lorica contracting to 1.10–1.17 o.d. below slight suboral expansion, continuing quite evenly for 1.54–1.88 o.d., expanding slightly in short cone (25–45°) for 0.2 o.d. to greatest diameter, 1.13–1.34 (1.23) o.d., below a segment of an inverted cone (14–23°) 0.8 o.d. in length, with straight sides and diameter at aboral end of 1.0 o.d. Aboral end a short, wide, inverted cone (120–135°), 0.25–0.30 o.d. in length, with straight sides. Tip pointed or rounded. Wall subuniform in thickness, in suboral region and lateral wall, thicker in lower cone, and thinnest in aboral end. Animal with 2 globular macronuclei, each 10 μ in diameter, and 2 small spherical micronuclei.

Seven loricæ: L., total, 130–156 (146.5). D., oral, 49–54 (51.7); greatest, 58–66 (63.5) μ.

Included by us (1929, pp. 259, 264) as a part of *parva*, in which species we placed loricæ both with and without inflated aboral regions. As here divided, *media* includes the shorter loricæ with more angular and inflated aboral regions, leaving in *parva* the longer, less angular, non-inflated loricæ.

At 6 stations, viz., at 2 and 4, respectively, in California Current and Drift; at 72–83 (76.5)°; 8 loricæ.

Undella minuta spec. nov.

Non Undella claparèdii var. *Dohrni*, Ostenfeld and Schmidt, 1901, p. 182 (see *U. dohrnii*).
Non Undella dohrni, Alzamora, 1929, pp. 7, 8, fig. 16 (see *U. declivis*).
Undella dohrni forma ? Jörgensen, 1924, pp. 39, 43, fig. 46.
Undella dilatata, partim, Kofoid and Campbell, 1929, p. 262 (for fig. 499, p. 259, see *U. dilatata*).

Lorica short test tube shaped; 2.54 o.d. Oral margin thin, sharp. Suboral region flaring slightly to 1.08 o.d. due to thickened wall. Bowl a segment of a

Undella ostenfeldi Kofoid and Campbell

Plate 24, fig. 8

Lorica slender, tubular goblet-shaped, subcylindrical anteriorly, with pointed aboral end; 1.91–2.17 (2.01) o.d., or 1.8 greatest diameter. Oral margin sharp, thinning on convex inner surface, with outer vertical. Oral region flaring in uppermost 0.5 o.d. Oral diameter 0.45–0.50 (0.48) t.l. Suboral thickening slight, greatest (0.9 o.d.) at 0.15–0.19 (0.17) t.l. below rim. Bowl expanding slightly posteriorly, with greatest diameter, 1.09–1.11 o.d., at 0.33–0.55 (0.45) t.l. from oral margin, tapering convexly to acute or narrowly rounded aboral end in convex cone of 90–105°. Wall thin throughout, its maximum thickness in suboral region and minimum at aboral end. Differs from *Proplectella ostenfeldi* in absence of inner collar.

Five loricæ: L., total, 46–51; length of collar, 8–9. D., oral, 23–25; collar, 21–23μ.

At 25 stations, viz., at 1, 1, 1, 1, 1, 3, and 17, respectively, in California, Peruvian, South and North Equatorial currents, Panamic Area, Easter Island Eddy, and Drift; at 68–81 (73.3)°; 37 loricæ.

Undella parva Kofoid and Campbell

Lorica stout tubular, 2.2–2.8 o.d. in length, cylindrical in anterior 0.66, intermediate region inverted, truncated, conical (33°), 0.75 o.d., in length, aboral end an inverted cone (120°), with slightly convex sides and rounded tip; 0.2 o.d. in length. Oral margin thinned, sharp; no suboral thickening but wall of intermediate cone slightly thickened, thinning distally in aboral tip. Wall thickest in intermediate cone, and thinnest in aboral tip.

Four loricæ: L., total, 145–180. D., oral, 60–67; aboral end of intermediate cone, 40–50μ.

Four stations, all in Drift; at 69–79 (73.8)°; 4 loricæ.

Undella peruana Kofoid and Campbell

Plate 24, fig. 19

Lorica very elongated, test tube-shaped, with a swollen, angular, thicker-walled aboral end; 3.0–4.4 (3.8) o.d. Oral margin thin, sharp, with concave (15–25°) outer and subvertical inner slope. Oral region

cone of 8°. Aboral region subhemispherical, its length 0.75 at its radius, with flattened antapex. Wall with thick laminae, thickest in lower bowl, thinning below.

L., total, 74. D., oral 31; greatest, 36μ.

Recorded by Jörgensen (1924) from off the east coast of Arabia.

with very slight distal flare, not over 0.1 o.d. from edge. Cylinder with diameter below rim 1.03–1.13 (1.09) o.d., increasing slightly and evenly to greatest diameter at 0.56–0.72 (0.66) t.l. from oral margin to 1.08–1.23 (1.13) o.d. Aboral end characteristically angled, flaring in a segment of a cone (15–17°) 0.08–0.10 t.l. and contracting below in a segment of an inverted cone (20–40°) 0.25–0.35 (0.30) t.l. Aboral end an inverted slightly convex cone of 90–110°. Tip bluntly pointed. Wall, uniformly thin in cylinder, doubling in thickness in upper wall of second cone, and decreasing to minimum in aboral cone. Animal filling 0.5 of cavity of lorica; with 2 large, oval macronuclei, each 10 by 18μ, and 18 membranelles.

Seven loricæ: L., total, 175–232 (206). D., oral, 48–60 (53.7); greatest, 60–72 (62.5)μ.

At 7 stations, viz., at 3 and 4, respectively, in Peruvian Current and Drift; at 68–72 (69.1)°; 30 loricæ.

Undella pistillum Kofoid and Campbell

Plate 24, fig. 20

Lorica a truncated cone of 15° with rounded base; 2.00–2.62 (2.21) o.d. Anterior cylinder and bowl not differentiated. Oral aperture 0.38–0.50 (0.46) t.l. in diameter. Oral region slightly everted. Oral margin broadly rounded, thinning slightly for 0.33 o.d. below edge. No differentiated oral rim. Suboral thickened zone not always well developed, vaguely defined, about 0.5 o.d. in length, with maximum diameter 0.5 o.d. below oral margin, causing slight external bulge to an external diameter of 1.11–1.22 (1.14) o.d., but not encroaching much upon lumen. Bowl not clearly differentiated, 0.30–0.40 (0.35) t.l. in length, measured to level of change in flare, increasing evenly in diameter as a truncated cone of 15° for 0.5 its length to maximum diameter of 1.10–1.33 o.d., then turning rather abruptly to form low, depressed, subhemispherical aboral end. Wall with maximum thickness in middle of bulge, half as thick in other parts of lorica, except for slight decrease on aboral end.

Three loricæ: L., total, 90–120. D., oral, 45–50; bulge, 50–64μ.

At 3 stations, viz., at 2 and 1, respectively, in California and Peruvian currents; at 67–83 (73)°; 3 loricæ.

Undella turgida Kofoid and Campbell

Plate 24, fig. 16

Lorica very broadly bowl-shaped, with bluntly pointed aboral region; 1.11–1.31 (1.19) o.d.; about as wide as long. Oral margin thin,

narrowly rounded. Oral region very slightly everted (10°). Oral aperture 0.80–0.88 (0.83) t.l. in diameter. Oral rim very low, clearly differentiated, 0.05–0.08 (0.06) t.l. in length. Bowl below rim very slightly flattened laterally in anterior 0.4, broadly rounded, truncated ovoidal, with greatest diameter, 1.10–1.38 (1.23) o.d., at, or shortly below, slight shoulder below oral rim. Aboral region contracting in lower half of bowl to a broadly rounded or convex cone (100°). Tip bluntly rounded or subacute. Wall with prisms in middle layer in 3 rows in thickened region below oral rim and 2 elsewhere; with maximum thickness (0.06 o.d.) below oral rim, thinning out evenly to not over 0.03 at tip.

Five loricæ: L., total, 41–44 (42.8). D., oral, 33–37 (35.6); greatest, 43–44 (43.4) μ.

At 6 stations, viz., at 1 and 5, respectively, in Galapagos Eddy and Drift; at 68–76 (73)°; 6 loricæ.

29. AMPLECTELLA Kofoid and Campbell

Undellidæ with lorica consisting of an anterior cylinder with rings and a short expanded aboral bowl; suboral region gradually thinning orally to entire oral margin; differentiated oral rim, suboral ledge and suboral thickening absent; 1–4 rings present on cylinder and generally one on bowl formed by outward buckling and thickening of wall; aboral end broadly rounded, rarely bluntly pointed; wall trilaminate without secondary prismatic structure in the intermediate layer; marine, eupelagic in tropical and semitropical seas. Type species *Amplectella collaria* (Brandt) K. and C. from the Sargasso Sea as figured by Brandt (1906, pl. 63, fig. 12).

Brandt (1906, 1907), Jörgensen (1924), and Laackmann (1909) included species of this genus in Undella. Brandt described *U. collaria* with var. *a* (=*Amplectella ampla* K. and C.) and var. *b insignis* (=*A. insignis* [Bdt.]). Laackmann (1909) added the species *U. monocollaria*. We (1929) established the genus with *A. collaria* as type; raised Brandt's two varieties to specific rank; and added three new species, *occidentalis, præacuta,* and *quadricollaria*. Brandt's *Undella collaria* var. *c* was assigned by us (1929) to *Undellopsis bicollaria* because of the suboral ledge.

Distinguished from Amplectellopsis by rings on cylinder as well as bowl; from Undella and Proplectella by well developed rings, the aboral angulations in Undella being the nearest approach to rings; from Undellopsis by absence of suboral ledge; and from Cricundella by presence of an expanded bowl.

Includes 8 species, of which 7 occur in Expedition material. Of the 8 species, 5 were new, all occurring in Expedition material. One, *bulbosa*, is described in this Report, and the other 4 were described in our *Conspectus* (1929). The 8 species, *insignis*, *occidentalis*, *collaria*, *monocollaria*, *bulbosa*, *ampla*, *præacuta*, and *quadricollaria*, form an imperfect series.

Amplectella ampla Kofoid and Campbell

Lorica with long, wide anterior cylinder with 2 narrow rings and depressed subangular bowl; 2.3 o.d. Oral margin sharp, gradually thinning for 0.2 o.d. in an angle of 12° in section. Oral rim not developed. Oral region flaring 5–10° for 0.3 o.d. Anterior cylinder 0.63 t.l., increasing in diameter from oral margin to first ring for 0.24 t.l., a truncated segment of a cone of 8°. First ring triangular in section with straight sides, with diameter of 1.32 o.d., with upper angle with axis 44°, and lower 40°. Interannular zone with flattened concave outer surface, increasing in diameter to second ring at 0.17 t.l. below first, with diameter of 1.42 o.d., with upper angle 52°, and lower 40°, with flat or slightly concave surfaces, and outer edge broadly rounded. Cylinder continuing below second ring as above for 0.22 t.l., increasing evenly in diameter posteriorly to 1.22 o.d. Bowl moderately inflated subangular, 0.37 t.l., less than half as long as anterior cylinder, and 0.54 its greatest width in length, with maximum diameter (1.69 o.d.) near middle, with upper surface slightly convex, forming angle of 55° with diameter. Wall below subangular equator nearly straight in section, forming an angle of 44° with slightly flattened aboral end of bowl. Aboral end rounded or flattened, 0.8 o.d. in diameter. Wall with finely prismatic intermediate layer of uneven thickness. Wall of anterior cylinder half as thick as in rings and bowl thinning near aboral end.

L., total, 119. D., oral, 51; first ring, 65; second ring, 69; greatest, 83 μ.

At 2 stations, viz., at 1 each in Easter Island Eddy and Drift; at 72–75°; 3 loricæ.

Amplectella bulbosa spec. nov.

Plate 25, fig. 3

Lorica stout bag-shaped, with rather short anterior cylinder with single flange-like ring, a stout, inflated bowl with a low aboral projection; 2.23 o.d. Oral margin sharp, with convex outer and oblique

inner surface, in section an angle of 25°. Anterior cylinder above ring 0.29 t.l., or 0.65 o.d., in length, with diameter above ring 1.06 o.d. Oral region flaring (10°) for 0.5 o.d. Ring flange-like, forming a cone of 60° in section, with narrowly rounded edge, 1.29 o.d. in diameter, asymmetrical, with upper angle 35° with axis, and lower one only 25°. Bowl below ring 0.71 t.l., or 1.63 o.d. in length, increasing in diameter from 1.1 o.d. at oral end for 1.0 o.d., to maximum diameter, 1.29 o.d., at equator, the same as ring above, a truncated cone of 21°, 0.9 o.d. in length. Aboral region baggy, depressed hemispheroidal, with horizontal radius 1.12 times vertical, and length below level of maximum diameter 0.75 o.d., with central aboral projection, a low inverted dome of 0.12 o.d. in length, with base nearly 0.5 o.d. in diameter. Lumen follows contour closely without entering ring.

Wall subuniform in thickness on cylinder, doubled on ring, decreasing on bowl, and thinnest in aboral projection.

L., total, 106; to ring, 30. D., oral, 50; ring, 67 μ.

At Sta. 4703, in Drift; at 73°; 1 lorica.

Amplectella collaria (Brandt) Kofoid and Campbell

Undella collaria, Hensen, 1911, p. 243.

Lorica with moderately long and comparatively slender anterior cylinder with 2 rings, depressed bowl with angled or rounded edge, and subhemispherical aboral end; 2.06–2.38 (2.30) o.d. Oral margin thinning out to rounded edge. Oral region flaring 5–10°, increasing distally for 0.3 o.d. Oral rim low, feebly differentiated, 0.22 o.d. in length, with outwardly sigmoid contour, in some individuals not developed and wall thinning gradually from first ring to margin. Anterior subcylinder 0.59–0.63 (0.61) t.l., with basal diameter 1.16 o.d. First ring at 0.24–0.27 (0.25) t.l. from oral margin, 1.10–1.35 (1.22) o.d. in diameter, upper angle 20–70° and lower 15–20°; ranging from broadly rounded to rather sharply angular contour. Second ring at 0.40–0.54 (0.46) t.l. from oral margin, 1.21–1.33 (1.30) o.d. in diameter, with same angular slopes as first ring. Cylinder below second ring gradually increasing in diameter as it merges with bowl. Bowl 0.37–0.41 (0.39) t.l., 1.54–1.78 (1.63) o.d. in diameter at widest level near middle, and 0.35–0.50 t.l. in greatest diameter. Angle of upper half of bowl between cylinder and widest level 30–45° from vertical, and that between widest level and antapex 60–70°, with surfaces outwardly convex. Aboral end broadly rounded, or slightly flattened. Wall thinning adorally in thickness in anterior cylinder,

0.10–0.16 o.d. in two rings, 0.11–0.17 in anterior and 0.10–0.12 in posterior part of bowl.

Five loricæ: L., total, 106–119 (114.2). D., oral, 51–63 (49.5); first ring, 55–63 (60.2); second ring, 61–67 (64.2); aboral, 70–90 (80.4) μ.

At 16 stations, viz., at 4 and 12, respectively, in Easter Island Eddy and Drift; at 70–81 (75.1)°; 34 loricæ.

Amplectella monocollaria (Laackmann) Kofoid and Campbell

Lorica with very long anterior cylinder with one ring and low, very wide, bowl with subangular ring; 2.29–2.50 (2.44) o.d. Oral margin thin, sharp, in section an angle of 10°. Oral region flaring up to 12° from above ring. Anterior cylinder 0.55–0.65 (0.61) total length in length, decreasing in diameter evenly, except for ring, from oral margin to bowl to 1.00–1.21 (1.13) o.d. below. Ring projecting, sharp-angled, 0.33–0.41 (0.38) t.l. from oral margin, with upper slope 50–60° from vertical, and lower 35–40°; 1.20–1.37 (1.27) o.d. in diameter. Cylinder below ring deeply concave outwardly, sometimes with outwardly convex median expansion, or more usually gradually expanding into bowl. Bowl much depressed, its length 0.5–0.6 its width, its diameter 1.55–1.80 (1.68) o.d. at equator; with equatorial edge, or ring, angular in most loricæ or slightly rounded in others; with upper angle of ring 32–40° from vertical, and lower one 50–70°; with outwardly convex surfaces. Aboral end broadly rounded or slightly flattened. Wall thinnest in anterior cylinder and aboral end, thickened in anterior ring and above widest part of bowl. Animal with cytosome filling posterior half of lorica, with 3 (?) ovoidal macronuclei.

Eight loricæ: L., total, 116–127 (122). D., oral, 46–53 (50); anterior diameter, 50–54; greatest, 75–92 (85.3) μ.

At 13 stations, viz., at 2, 2, 1, 2, and 6, respectively, in California and Mexican currents, Galapagos and Easter Island eddies, and Drift; at 68–83 (74.8)°; 34 loricæ.

Amplectella occidentalis Kofoid and Campbell

Plate 25, fig. 4

Lorica vase-like with feebly developed rim and bowl; with a single, prominent, sharp-angled ring on anterior cylinder; bowl with subangular antapex; 2.16–2.41 (2.30) o.d. Oral margin sharp, with slightly convex outer and flaring (10°) inner surface, 0.12 o.d. in length, in section an angle of 20°. Oral diameter 0.42–0.45 t.l. Anterior cylinder

0.54–0.63 (0.57) t.l., or 1.4 o.d. in length, expanding evenly from oral margin as a segment of an inverted cone of not over 5° to its junction with bowl, with basal diameter of 1.2 o.d. Single ring wedge-shaped in section, with rounded edge, 0.67–0.90 (0.77) o.d. below oral margin, with diameter of 1.32–1.45 (1.36) o.d., asymmetrical, with upper slope 35–45°, and lower one 45–55° from vertical. Bowl subelliptical in section, bluntly angled below, 0.37–0.46 (0.43) t.l. in length, expanding evenly from lower end of cylinder to greatest diameter (1.27–1.55 [1.45] o.d.) at 0.75–1.60 o.d. from oral margin, with upper slope 12–20° from vertical, contracting aborally abruptly as an inverted cone (115–120°) with convex sides. Antapex bluntly pointed. Lumen scarcely enters ring. Wall thinnest in anterior cylinder, thickest in ring and upper bowl, and thinning posteriorly.

Three loricæ: L., total, 106–110; to central ring, 33–42; from ring to posterior expansion, 40-45; from posterior expansion to antapex, 28–30. D., oral, 44–49; ring, 62–64; greatest, 62–73μ. The measurements published by us (1929, p. 254) for this species included those of *A. bulbosa*. The removal of this is the cause of the changes in dimension recorded here.

At 6 stations in Drift; at 68–81 (75.2)°; 7 loricæ.

Amplectella præacuta Kofoid and Campbell

Plate 25, fig. 12

Lorica with moderately long anterior cylinder with 2 rings, and short bowl with sharply angular aboral end; 2.24 o.d. Oral margin sharp, in section an angle of 22°, with faintly sigmoid outer and oblique inner face. Oral region flaring 20° for 0.3 o.d. Oral rim feebly developed, 0.14 o.d. in length, expanding below to 1.14 o.d. Anterior cylinder 0.64 t.l. First ring at 0.26 t.l. from oral margin, with diameter of 1.29 o.d., upper angle 24° and lower 40°, with both upper and lower contours slightly concave. Second ring at 0.47 t.l. below oral margin, 1.33 o.d. in diameter, with same angular slopes and form as first. Interannular region asymmetrically concave, deeper aborally, with least diameter 1.1 o.d. Cylinder below second ring again contracting immediately to 1.1 o.d., increasing in a concave truncated cone (30°) as it merges with upper bowl. Bowl 0.36 t.l., with equatorial diameter of 1.57 o.d. at little below middle of bowl, or 0.76 t.l. from oral margin. Upper part of bowl wide, truncate segment of cone (70°), with slightly concave sides. Aboral half of bowl sharply angular below, inverted, slightly convex cone (120°), with length 0.3 its basal diameter. Outer rim of bowl

broadly rounded. Antapex blunt. Wall subuniform in thickness throughout with slight increases in rings and anterior bowl, thinning slightly in aboral region.

L., total, 105. D., oral, 47; first ring, 62; second ring, 63; aboral, 74μ.

At Sta. 4695, in Easter Island Eddy; at 74°; 1 lorica.

Amplectella quadricollaria Kofoid and Campbell

Plate 25, fig. 13

Lorica with long anterior cylinder with 4 bulging, rounded rings, and low, much depressed bowl; 2.2 o.d. Oral margin broadly rounded, with concave outer and convex inner surface thinning slightly. Oral region flaring slightly. Oral rim scarcely differentiated from flare into first ring. First ring less developed than others, 1.14 o.d. in diameter, at 0.21 t.l. below oral margin. Second ring 1.22 o.d. in diameter, 0.45 o.d. below oral rim. Third ring 0.39 t.l. below oral margin, with maximum diameter of 1.22 o.d. Fourth ring with maximum diameter of 1.24 o.d., 0.51 t.l. from oral margin. All rings bulging, with broadly rounded periphery, with concave, gutter-like interspaces with depth increasing to 0.15 o.d. above bowl, asymmetrical, with upper slope usually shorter. Cylinder increasing slightly and regularly in diameter from oral margin to 1.06 o.d. at base, 0.57 t.l. in length. Bowl narrowly elliptical in section, 0.43 t.l., with diameter 1.1 its length, expanding evenly, with outwardly convex contour from aboral end of cylinder, with maximum diameter (1.42 o.d.) midway. Aboral end broadly rounded. Wall thinning adorally, subuniform in thickness elsewhere, except in thinning suboral region.

L., total, 101; anterior cylinder, 63; bowl, 38. D., oral, 49; first ring, 55; second ring, 60; third ring, 59; fourth ring, 62; bowl, 70μ.

At Sta. 4705, in Drift; at 72°; 2 loricæ.

30. AMPLECTELLOPSIS Kofoid and Campbell

Undellidæ with lorica without suboral ledge; anterior cylinder without rings, or only with a feebly developed one merging gradually with expanded bowl; wall trilaminate; marine, in tropical seas. Type species *Amplectellopsis biedermanni* K. and C., from Sta. 4701 in Drift of Eastern Tropical Pacific. Length of lorica 107–119μ, and oral diameter 45–50μ.

Like Amplectella in form and proportions, differing from it in absence of rings on cylinder and lack of internal bulging, even in in-

cipient ring in *biedermanni*. It represents stages morphologically antecedent to Amplectella and Undellopsis. The addition of rings on the anterior cylinder leads to the former, and the differentiation of a suboral ledge, to the latter.

Established by us (1929) for two new species, *angularis* and *biedermanni*, both from Expedition material.

Amplectellopsis angularis Kofoid and Campbell

Plate 25, fig. 9

Lorica simple, stout vase-like, subcylindrical above, with expanding bowl with angular ring very near flattened aboral end, without ring on cylinder; 2.22–2.54 (2.36) o.d. Oral margin thinned, rather sharp. Oral region flaring 7°. Oral diameter 0.42–0.45 (0.42) t.l. Anterior region concave subconical (8°), 0.52–0.62 t.l., increasing evenly to 1.02–1.14 o.d. above bowl. Bowl 0.38–0.44 t.l., with upper part a truncated segment of a convex cone (8°) 0.5 o.d. in length, and lower 0.3 o.d., a depressed hemisphere with length 0.2 diameter; with an angular or bluntly rounded ring at 0.80–0.86 t.l. from oral margin, 1.47–1.67 (1.56) o.d. in diameter across ring. Wall hyaline, with very distinct, uniform inner and outer lamellæ enclosing a homogeneous intermediate layer three times thickness of a lamella; thinning gradually adorally in anterior subcylinder, thickest in anterior bowl, and across ring, thinnest aborally.

Seven loricæ: L., total, 109–119 (114.6). D., oral, 45–50 (48.4); at ring, 68–80 (74.7) μ.

At 12 stations, viz., at 2, 1, and 9, respectively, in Easter Island and Galapagos eddies, and Drift; at 72–81 (76)°; 21 loricæ. Type locality Sta. 4689, and *not* 4685 as earlier stated by us (1929, p. 256).

Amplectellopsis biedermanni Kofoid and Campbell

Plate 25, fig. 2

Lorica stout vase-like, or like a Mexican drinking cup, with slightly expanded bowl with long upper and short lower regions, angular equatorial ring and a low, rounded aboral end, 2.37–2.51 o.d. Oral margin thinned to sharp edge in an angle of 5°. Suboral region flaring 10°. Oral diameter 0.40–0.41 t.l. Anterior region cylindrical above incipient ring, forming 0.38–0.41 t.l., below which a slight, broadly rounded, annular expansion of outer wall attains a diameter of only 1.16 o.d. Bowl asymmetrically divided into longer upper region and

watch-glass shaped aboral region; the upper a truncated segment of a cone (35°), terminating below in an outwardly projecting angular ring; 0.87 t.l. from oral margin, with upper slope of 15–20° and lower 40–50° from vertical; and diameter 1.55–1.67 o.d. Aboral region a low, inverted, depressed dome with length 0.25 its diameter at ring. Wall hyaline, with very distinct, thick, double-contoured inner and outer lamellæ, uniform in thickness, enclosing a middle homogeneous layer; subuniform in thickness in anterior cylinder, doubling in thickness in incipient ring and anterior part of bowl, and thickest in equatorial ring.

Two loricæ: L., total, 107–113. D., oral, 45; ledge, 52; greatest, 70–75μ.

At Sta. 4701, in Drift; at 72°; 2 loricæ.

31. UNDELLOPSIS Kofoid and Campbell

Undellidæ with a stout, tall cup-shaped lorica; suboral ledge well developed, with outer sigmoid outline; lorica with or without expanded aboral region forming a bowl; with or without rings; aboral end hemispherical, rounded, flattened, squarely truncated, or umbilicated; wall trilaminate; marine, from tropical and subtropical seas. Type species *Undellopsis marsupialis* (Bdt.) K. and C., from Atlantic North Equatorial Current (Brandt, pl. 63, fig. 8).

In shape, proportions, rings, and wall allied to Amplectella and Amplectellopsis. In suboral ledge, number of rings (6 in *umbilicata*), and diversity of structure of aboral end, it reaches the highest structural evolution attained in the Undellidæ, surpassed in length and volume only by some species of Undella. Suboral ledge does not occur elsewhere in the Undellidæ, but is characteristic of Epicancella, Epiorella, and Ptychocylis, cup-shaped genera which have considerable resemblance to Undellopsis in suboral structure and presence of rings, but in which wall structure is wholly different and a pointed aboral horn is usually present. The resemblances between Undellopsis and Ptychocylis are so striking as to suggest relationship rather than convergence, were it not for the striking distinctness in wall structure.

Established by us (1929) to include, beside 5 new species, *marsupialis* (Brandt) and *tricollaria* (Laackmann), assigned to it from Undella.

Contents. Contains 14 species, of which 9 are in Expedition collections, and 11 new, 8 of which were described in the *Conspectus* (1929) and 3 in this Report. Of the 11 new species, 9 are from Expedition collections. Subdivided by us (1929) into two subgenera, Undellopsis K. and C. and Undellicricos K. and C.

Subgenus UNDELLOPSIS Kofoid and Campbell

Undellopsis with no rings on lorica below suboral ledge; bowl differentiated from anterior cylinder only in *lineata* and *entzi*, aboral end rounded, flattened, angled, or pointed, never hemispherical; marine in tropical seas. Type species *Undellopsis marsupialis* (Bdt.) K. and C. from the North Equatorial Current of the Atlantic (Brandt, 1906, pl. 63, fig. 8). Contains 1 series, including *marsupialis, cubitum, entzi, lineata, pacifica,* and *subangulata.*

In our *Conspectus* (1929) we included *insignata* in this subgenus, but we now transfer it to Undellicricos because of its well developed bowl, and especially because of equatorial ring on bowl.

Subgenus UNDELLICRICOS Kofoid and Campbell

Undellopsis with one to six rings; lorica more or less differentiated into anterior cylinder and bowl except in *nuda* and *umbilicata;* aboral end hemispherical or broadly rounded, except in *truncata,* in which it is flattened, and *umbilicata,* in which it is umbilicated; marine, in tropical seas. Contains one series, including *bicollaria, insignata, anularius, angulata, tricollaria, truncata* sp. nov., *umbilicata,* and *nuda* sp. nov. Kofoid and Campbell mss. based on one of Laackmann's two figures (1909, p. 470, pl. 49, fig. 19) of *Undella tricollaria.*

Undellopsis angulata spec. nov.

Plate 25, fig. 7

Udps. bicollaria, partim, K. and C., 1929, p. 272 (for *Udps. bicollaria* see K. and C., fig. 521).

Lorica stout, inflated thimble-shaped, with three very prominent rings, an anterior cylinder with ring-like ledge and one ring, and annulate, much depressed, subspheroidal bowl, 2.4 o.d. Oral region gradually flaring (15°) internally for 0.5 o.d. Oral margin rounded. Oral rim expanding within 0.18 o.d. below oral margin into heavy suboral ledge 1.24 o.d. in diameter, with outer slope sigmoidal and inner sloping 17° from vertical, with outer edge slightly rounded in angle of 130°. Cylinder contracting evenly below ledge for 0.88 o.d. to not over 1.0 o.d. in a segment of a concave inverted cone of 34°, 0.4 o.d. in length, then expanding in a segment of a concave cone of 75° to first ring, 1.28 o.d. in diameter; contracting again at 0.95 o.d. below oral margin to 1.23

o.d. in a less concave constriction than one above it, with upper and lower concave cones of 45° and 40°, and 0.23 and 0.36 o.d. in length, respectively; expanding again evenly to equatorial ring in bowl 1.55 o.d. in diameter. Both rings sharply angled (105° and 122°, respectively), not so rounded outwardly as suboral ledge; 0.6 o.d. apart. Bowl depressed hemispheroidal, 1.0 o.d. in length; its aboral part forming an inverted dome with vertical radius 0.69 its horizontal and length of 0.55 o.d.

Wall subuniform in thickness throughout, except for abrupt aboral thinning, slight increase in rings, and very thin aboral region.

L., total, 102. D., oral, 50; ledge, 62; first ring, 64; second ring, 55μ.

Included by us (1929, p. 272) with *Udps. bicollaria*, here separated on basis of its more slender proportions, slighter middle ring, and equatorial ring instead of groove.

At Sta. 4681 in Drift; at 68°; 1 lorica.

Undellopsis anularius Kofoid and Campbell

Plate 25, fig. 5

Udps. anularius, partim, K. and C., 1929, pp. 267, 374 (for fig. 520 see *Udps. truncata*).

Udps. anularis K. and C., 1929, p. 271; *lapsus pennæ;* see p. 374.

Lorica short pestle-shaped, with long anterior cylinder with one ring, feebly developed suboral ledge, and subangular, spheroidal bowl, 2.49 o.d. Oral margin thinned, narrowly rounded. Oral rim feebly developed, with outer slope outwardly concave and inner subvertical, 0.26 o.d. in length, in section an angle of 20°, flaring below into ledge. Suboral ledge broadly rounded, with diameter of 1.16 o.d. at 0.26 o.d. below oral margin. Suboral region cylindrical. Anterior cylinder 0.56 t.l. to first ring, outwardly slightly concave, with diameter of 1.21 o.d. at 0.41 t.l. below oral margin, with upper slope of 20° and lower of 18°, outwardly rounded, in one lorica not well developed. Cylinder contracting below ring for 0.13 t.l. as a truncated inverted segment of a cone of 30°, merging below with anterior end of bowl at deep constriction to 1.0 o.d. Bowl 0.4 t.l., subspheroidal, divided into anterior, more rapidly contracting section, 0.12 t.l., a segment of a slightly concave cone of 70°, and terminal section 0.3 t.l., 1.44 o.d. in diameter, somewhat exceeding a hemisphere in contour, and with traces of posterolateral angulation. Second ring feebly developed, at junction of two

sections of bowl, at 0.66 t.l. from oral margin. Aboral end subhemispherical, with apical bulge due to externally thickened wall. Wall thickest in suboral ledge, subuniform elsewhere, except for very slight thickening in rings and aboral tip, thinning radially around the tip.

L., total, 112. D., oral, 45; ring, 52; greatest, 60μ.

Undellopsis truncata was included by us (1929, p. 271) in *Udps. anularius*, modifying its content only in the range in dimensions and in the reference in the comparison with other species to the "more flattened aboral end."

At 2 stations, viz., at 1 each in Easter Island Eddy and Drift; at 72–75°; 3 loricæ.

Undellopsis cubitum Kofoid and Campbell

Plate 25, fig. 14

Lorica a stout cylinder with very short oral rim, short, slightly conical aboral cone, and squarely truncated aboral end; 2.4 o.d. Oral region contracting slightly for 1.0 o.d. Oral margin acute, thinning down abruptly. Oral rim low, 0.09 o.d. in length, with inner wall subvertical and outer wall sloping outwardly 30–45°. Suboral ledge angled (140°), with diameter of 1.2–1.3 (1.25) o.d. Bowl cylindrical, contracting less than 2° posteriorly, to posterior 0.12–0.28 (0.24), contracting here more sharply to form inverted, truncated segment of a cone of 15–20°, with flat or slightly outwardly concave sides. Aboral end abruptly truncated and slightly rounded, 1.08–1.10 (1.09) o.d. in diameter. Wall subuniform in thickness, thicker in suboral ledge, thickening in sides of aboral cone, thinning down in rounded aboral end.

Two loricæ: L., total, 117–123. D., oral, 49–51μ.

At Sta. 4713 in Galapagos Eddy; at 73°; 5 loricæ.

Undellopsis entzi Kofoid and Campbell

Plate 24, fig. 18

Lorica like a small, stout saltcellar with flange, neck, and bowl with flat aboral end; angular suboral ledge at lower level than usual; 2.21–2.42 (2.23) o.d. Oral margin narrowly rounded. Oral rim unusually wide, with concave outer and convex inner slope, in section an angle of 25°. Suboral ledge outwardly subangular (140°), 0.25 o.d. in width, with greatest diameter, 1.2 o.d., at 0.27 o.d. below oral margin. Suboral region flaring 10° for 0.45 o.d. Oral opening 0.45 t.l. Anterior

subcylinder 0.5 t.l. Anterior section subcylindrical continuing for 1.0–1.4 o.d. below suboral ledge, its diameter increasing evenly to 1.3–1.6 o.d. above bowl. Bowl with shape of an angular kettle with greatest diameter 1.7 o.d. at 1.5–1.7 o.d. below oral margin; its upper part truncated segment of cone of 68–88°; its lower part segment of slightly convex inverted concave cone of 42–50°, with angles sharper than that of suboral ledge. Aboral end squarely truncated, forming a wide, flattened disc of same diameter as oral opening. Wall hyaline and homogeneous, with neither double contour of lamellæ nor prismatic structure distinguishable; thickest in suboral ledge and angle of bowl, slightly thinner in anterior cylinder and flat aboral end.

Two loricæ: L., total, 108–115; to first ring, 12–14; from ring to bowl, 56–65; bowl, 38. D., oral, 48–52; suboral, 56–62; bowl, 75–85; aboral, 46–47 μ.

At Sta. 4679 in Drift; at 69°; 2 loricæ.

Undellopsis insignata Kofoid and Campbell

Plate 25, fig. 1

Lorica shaped like a saltcellar with laterally concave cylinder shorter (0.8) than basin-shaped bowl with widely flaring ring; 2.48 o.d. Oral margin narrowly rounded. Oral rim 0.25 o.d. in length, with deeply concave outer and convex oblique inner slope. Suboral ledge outwardly rounded, 1.24 o.d. in diameter, its upper concave slope 28°, and lower, more nearly flat 45° from vertical. Oral region flaring widely (27°) for 1.0 o.d. Oral diameter 0.29 t.l. Anterior cylinder 0.43 t.l., deeply concave laterally, contracting to 1.0 o.d., increasing evenly below middle to 1.14 o.d. at junction with bowl. Bowl 0.57 t.l., with flaring upper part, a short, concave and truncated segment of a cone of 85°, 0.14 t.l., merging at its base with thickened, projecting ring of bowl. Ring 0.57 t.l. from oral margin, 1.76 o.d. in diameter, with concave oral and aboral slopes, in section an angle of 75°. Lower section, below ring, bowl-shaped, with almost straight sides for nearly 0.67 its length, contracting below abruptly to a broadly rounded, somewhat depressed aboral end. Aboral region less than a hemisphere, its length 0.33 its diameter. Wall thickest in suboral ledge and ring, gradually increasing toward ring on bowl, thinning in aboral end. Lumen not extending into suboral thickening, but entering ring.

L., total, 104; to first ring, 7; from oral to posterior ring, 53. D., oral, 30; greatest, 74 μ.

At Sta. 4583 in California Current; at 83°; 1 lorica.

Undellopsis pacifica Kofoid and Campbell

Plate 24, fig. 22

Lorica long thimble-shaped, subcylindrical, with depressed, broadly rounded aboral end, 1.86–2.23 (2.13) o.d. Oral region contracted slightly only within rim. Oral margin broadly rounded. Oral rim thinning out abruptly, very low, less than 0.1 o.d. in length, with inner face slightly incurved and outer sloping 20–30° due to amount of thickening. Suboral ledge outwardly rounded, much thickened, upwardly concave, 1.12–1.20 o.d. in diameter. Lorica below ledge either cylindrical, contracting slightly (up to 3°) aborally, or concave above middle and expanding aborally to a diameter of 1.00–1.32 (1.17) o.d. at 0.75 t.l. from oral margin. Aboral end broadly rounded, less than a hemisphere, 0.25–0.45 its width in length. Wall thickest in suboral ledge, thinning aborally in cylinder and in aboral center. Animal preserved in a number of loricæ, with 2 macronuclei, oval or bean-shaped, from 10 by 12 μ to 12 by 25 μ, in interfission phases. Late fission phases with 4 oval macronuclei, from 12 by 14 μ to 16 by 20 μ, associated in two pairs, one pair posterior and one anterior to new, laterally located peristome. In one individual 9 membranelles on one side. Lower part of cytosome contained skeletal plates of dinoflagellates and other food detritus.

Ten loricæ: L., total, 103–122 (108.5). D., oral, 48–55 (51.8); greatest, 54–66 (59.8) μ.

At 17 stations, viz., at 3, 4, 2, 2, and 6, respectively, in California and Peruvian currents, Panamic Area, Galapagos Eddy, and Drift; at 66–83 (72.7)°; 32 loricæ.

Undellopsis tricollaria (Laackmann) Kofoid and Campbell

Lorica a slender truncated cone, with heavy suboral ledge and 3 rings, low, kettle-shaped bowl with hemispheroidal aboral end; 2.00–2.21 (2.10) o.d. Oral margin thin, subacute. Oral region contracting inwardly very abruptly within a cone of 12–32° above level of suboral ledge. Oral rim suberect, incurved, with concave to sigmoid outer slope and concave inner slope, in section an angle of 25–40°. Suboral ledge 0.20–0.25 o.d. below oral margin, 1.22–1.33 (1.27) o.d. in diameter, with outer edge a broadly rounded angle (115°), with sides outwardly concave above and convex below. Subcylindrical part of lorica below ledge, measured either on rings or in concavities between them, narrowly conical (9–14°), encircled by three very prominent rings, two

on cylinder and one on equator of bowl. First and second rings tending to be closer together than either ledge and first or second and third rings. Upper two concavities subequal and symmetrical, the third wider, asymmetrical, deeper near second ring. First ring at 0.25–0.35 (0.30) t.l. below oral margin, 1.23–1.37 (1.29) o.d. in diameter, its upper angle 22–32°, its lower 40–52°. Second ring at 0.40–0.50 (0.46) t.l. from oral margin, 1.30–1.49 (1.38) o.d. in diameter, its upper angle 45–52°, the lower 30–62°. Wall contracting rather suddenly below this ring for less than 0.1 t.l., expanding quickly below at an angle of 18–30° from vertical, with straight or very slightly convex walls as lorica widens into bowl. Third ring on equator at 0.64–0.73 (0.70) t.l. from oral margin, 1.36–1.68 (1.54) o.d. in diameter. Outer contour of lorica as a whole presenting a linear series of regular concavities and elevations of slightly increasing diameters formed by suboral ledge and 3 successive rings. Bowl kettle-shaped, 0.8–1.0 o.d. in length measured from third concavity, depressed subspheroidal in contour, with protuberant angular ring at its greatest diameter somewhat above its middle. Upper bowl a segment of a cone of 32–53°, 0.35–0.55 o.d. in length; the lower an inverted, depressed dome, 0.5–0.7 o.d. in length. In contour aboral region of shorter loricæ nearly segment of a sphere, of longer ones a prolate hemisphere. Equatorial ring varying greatly in development, always protuberant and sometimes nearly as emergent as those on cylinder above, subhemispherical, 0.35–0.45 its width in length. Wall hyaline, with thin bilaminate lamellæ enclosing homogeneous, intermediate, thicker layer thickest in suboral ledge, slightly thickened in rings, uniformly thinner in lower bowl.

Six loricæ: L., total, 98–106 (102.0). D., oral, 47–51 (48.0); suboral ledge, 60–63 (61.2); first ring, 62–69 (64.7); second ring, 64–71 (68.7); third ring, 72–80 (74.8) μ.

At 11 stations, viz., at 1, 1, 4, and 5, respectively, in California and Peruvian currents, Easter Island Eddy, and Drift; at 68-83 (73.1)°; 19 loricæ.

Undellopsis truncata spec. nov.

Plate 25, fig. 10

Udps. anularius, partim, K. and C., 1929, p. 271 (for fig. 520 see *Udps. anularius*).

Lorica like a tall saltcellar, with a long neck with flange, ring, and expanded, aborally flattened, subangular bowl; 2.22–2.46 o.d. Oral margin moderately thick, narrowly rounded. Oral rim with outwardly concave (25°) sigmoid slope and inner oblique one, in section an angle

of 22°, expanding evenly to ledge. Suboral ledge 0.24–0.27 o.d. below oral margin, with diameter of 1.08–1.11 o.d., and broadly rounded edge. Suboral region flaring 15° internally for 0.5 o.d., more abruptly near margin. Cylinder, measured to center of concavity above bowl, 1.33 o.d. in length. Ring submedian in cylinder at 0.92–0.96 o.d. below oral margin, outwardly rounded subangular (90°), with diameter of 1.11–1.16 o.d. Contour between suboral ledge and first ring shallowly concave, constricted to 1.03 o.d. Cylinder below ring contracting in an inverted concave segment of a cone of 45° to 1.0 o.d. at 0.35 o.d. below ring. Bowl kettle-shaped, 1.00–1.17 o.d. in length; upper part a segment of a concave cone (90°), 0.33 o.d. in length, expanding at 1.48–1.60 o.d. below oral margin, or 0.56–0.64 o.d. to greatest diameter (1.40–1.45 o.d.) in angular ring on equator of bowl; lower section an inverted truncated cone (45°), 0.65 o.d. in length. Aboral end flattened, slightly convex, 0.68 o.d. in diameter, with rounded edge. Wall thickest in suboral ledge and all rings, subuniform elsewhere.

Two loricæ: L., total, 110–111; to suboral ledge, 12; to ring, 43–46; to greatest diameter of bowl, 72–74. D., oral, 45–50; suboral ledge, 50–54; first ring, 50–58; ring on bowl, 63–68 μ.

At Sta. 4687 in Drift; at 73°; 2 loricæ.

Undellopsis umbilicata Kofoid and Campbell

Plate 25, fig. 11

Lorica a stout, thick-walled cylinder with thick, well developed suboral ledge, with 3–5, usually 3, equidistant rings, increasing distally in prominence, and short, narrower aboral cylinder with an umbilicated, introverted bottom; 2.10–2.27 (2.18) o.d. Oral margin narrowly rounded. Oral rim thin, with slightly concave outer and subvertical inner slope, in section an angle of 15–20°. Suboral ledge 0.10–0.18 (0.14) t.l. from oral margin, forming a subangular (135°) or outwardly rounded band; with upper slope 25–36°; lower, usually less convex and often somewhat longer slope, 22–33° from vertical; with diameter of 1.09–1.22 (1.18) o.d. Oral region flaring internally in a segment of an inverted cone of 15° in uppermost 0.5 o.d. Main body of lorica subcylindrical; in some with slight aboral flare above contracted section; in others with distinct, distal contraction; often somewhat asymmetrically cask-shaped, with bulge below middle; 0.64–0.75 (0.72) t.l. Aboral taper not exceeding 5–12° from vertical axis. Rings 3–5 on cylinder, usually 3, but 4 or 5 are not uncommon, so that lorica as a

whole presents a contour with 5–7 rings, including suboral ledge and most distal one around aboral end. Rings increasing in prominence distally, being closer together in case of larger numbers. First ring at 0.34–0.50 (0.42) t.l. from suboral ledge, with a diameter 1.02–1.22 (1.10) o.d., outwardly angular, with a long upper slope of 15–30° and short lower one of 7–35°. Between suboral ledge and first ring a bulge or incipient ring of more or less prominence sometimes interpolated. Second ring at 0.12–0.18 (0.14) t.l. from first, and with diameter of 1.02–1.21 (1.10) o.d.; its upper surface a flat slope of 10–24°; its lower a short, flat one of 15–30°. Third ring at 0.12–0.18 (0.14) t.l. from second ring, its diameter 0.86–1.13 (1.00) o.d., with longer upper flat slope of 8–12° and lower of 48–54°. In some loricæ another ring interpolated between second and third, and in others a fourth below third. Aboral section a short cylinder with an umbilicated, introverted bottom, like that of a bottle, 0.13–0.20 (0.16) t.l., with diameter of 0.66–0.86 (0.77) o.d. Aboral region extremely complex and unlike that of any other of the Tintinnoinea; introverted and umbilicated. Aboral end containing an introverted, flattened dome, 0.5 length of aboral cylinder. Projecting aborally from this introverted dome is a button-like, subhemispherical structure extending aborally into cavity of dome, about half length of aboral cylinder, with greatest diameter 0.2–0.3 (0.26) o.d. Wall with prismatic intermediate layer, with prisms in three layers, increasing to five in suboral ledge; thickest in suboral ledge and about half as thick elsewhere.

Five loricæ: L., total, 106–119 (115.4); to ledge, 12–14 (12.4); from ledge to first ring, 36–53 (49.4); from first to second ring, 14–18 (15.8); from second to third ring, 14–18 (16.4); third ring to aboral end, 15–22 (19.2). D., oral, 50–53 (51.8); ledge, 58–65 (60.2); first ring, 51–65 (57.0); second ring, 52–64 (56.0); third ring, 43–60 (51.8); base, 33–46 (39.6) μ; number of rings, 4–6.

At 5 stations, viz., at 3 and 2, respectively, in Easter Island Eddy and Drift; at 68–74 (71.8)°; 7 loricæ.

32. CRICUNDELLA Kofoid and Campbell

Undellidæ with a cylindrical or subcylindrical lorica; no suboral ledge; no expanded bowl; 2–4 rings present; aboral region hemispheroidal or contracted; wall trilaminate; marine, in tropical seas. Type species is *Cricundella tridivisa* (Brandt) K. and C. from Atlantic South Equatorial Current.

A parallel development of a cylindrical lorica with numerous rings occurs in the subgenus Undellicricos of the genus Undellopsis. Cricundella has definite relationships to Amplectella, Amplectellopsis, and Undellopsis with stout, ringed loricæ, but it also exhibits clearly the influence of the factor of aboral contraction and elongation, which emerges in other genera with considerably elongated loricæ. In Undella the elongation has proceeded to a considerable extent, but the contraction is only feebly expressed, being seen in the development of an aboral point in *U. parva, peruana, attenuata,* and *hyalina,* and in a contraction to an aboral subcylindrical section in *U. bulla,* recalling that in *Cricundella quadridivisa.* In Proplectella elongation is less extensive and less developed than in Undella and Cricundella, but aboral contraction is better developed, though only in the inverted conical type.

Contains 3 species, *tridivisa* from the Atlantic, and *quadricincta* and *quadridivisa* from Expedition collections, both new (K. and C., 1929).

Cricundella quadricincta Kofoid and Campbell

Plate 25, fig. 6

Lorica shaped like an elongated ringed finger cot, divided into 5 parts by 4 prominent ridge-like rings, the lowermost forming inverted, dome-like aboral end; not divisible into cylinder and bowl as in Amplectella; 2.18–2.97 (2.46) o.d. Oral margin thin, sharp, with convex slopes. Oral region contracting above first ring in a cone of 35°. Oral diameter 0.26–0.46 (0.39) t.l. Anterior 0.70–0.78 (0.76) of lorica basically a cylinder. Suboral cavity inflated evenly from oral margin aborally to first ring in an outward, slightly convex cone of 12°. First ring at 0.11–0.19 (0.12) t.l. from oral margin, 1.20–1.56 (1.23) o.d. in diameter, with upper slope outwardly concave or straight (28–37°), and lower 24–35°. Second ring at 0.20–0.27 (0.23) t.l. from first, 1.30–1.80 (1.36) o.d. in diameter, with upper slope 56–67° and lower 67–75°. Third ring at 0.19–0.32 (0.22) t.l. from second, 1.30–1.73 (1.33) o.d. in diameter, with upper, outwardly rounded slope 40–45°, and lower 45–60°. Fourth ring at 0.19–0.31 (0.22) t.l. below third, 1.25–1.67 (1.34) o.d. in diameter, with upper, outwardly rounded slope 40°, and lower almost horizontal. All interannular sections are only slightly concave approaching subcylindrical contour. Aboral region an inverted hemispherical dome, 0.38–0.44 (0.41) t.l. in length. Aboral end slightly depressed, its vertical radius 0.5 its basal diameter (1.0 o.d.),

and upper region a convex inverted segment of a cone of 35°. Wall with prisms in 2 layers; of uniform thickness except in thicker rings. Animal large, filling 0.6–0.8 of lorica even when contracted, with 2 large oval macronuclei each 7 by 14 μ to 10 by 18 μ, and 2 oval micronuclei 3 by 5 μ adjacent to macronuclei, and 20–22 membranelles. A new peristome at the side of the body with a new spiral membranelle zone present in one individual approaching binary fission. A number of large vacuoles were present.

Six loricæ: L., total, 85–119 (96.7); to first ring, 10–13 (11.5); first to second rings, 19–33 (23.0); second to third rings, 17–29 (21.3); third to fourth rings, 18–28 (21.1); fourth ring to aboral end, 23–39 (23.1). D., oral, 38–40 (37.7); first ring, 47–50 (47.0); second ring, 50–54 (51.9); third ring, 51–53 (52.3); fourth ring, 50–52 (50.5) μ.

At 9 stations, viz., at 4 and 5, respectively, in Easter Island Eddy and Drift; at 72–81 (73.8)°; 19 loricæ.

Cricundella quadridivisa Kofoid and Campbell

Plate 25, fig. 8

Lorica tall tumbler-shaped, without base; 2.66–3.22 (2.74) o.d. Oral margin thinned, acute. Oral diameter 0.31–0.35 (0.34) t.l. Suboral cavity flaring (5°) for not over 0.14 o.d. below oral margin. Suboral wall with concave outer and convex inner slopes. Anterior cylinder 0.53–0.63 (0.60) t.l., with four subequidistant rings, not expanding posteriorly. First ring outwardly rounded, at 0.09–0.12 (0.11) t.l. below oral margin; 1.13–1.23 (1.19) o.d. in diameter, with upper slope 30–40°, and lower 30–51° from vertical. Second ring at 0.18–0.24 (0.21) t.l. from first; 1.23–1.40 (1.29) o.d. in diameter, with upper slope 55–60°, and lower 45–65°. Third ring at 0.14–0.17 (0.15) t.l. from second, with upper slope 48–52° and lower 40–43°, 1.20–1.38 (1.30) o.d. in diameter. Fourth ring at 0.14–0.21 (0.16) t.l. from third, 1.21–1.51 (1.27) o.d. in diameter, with upper slope of 22–27° and lower 65°. Aboral region 0.32–0.38 (0.36) t.l., divided into an anterior, truncated, inverted cone of 45–65° below fourth ring, 0.5 aboral region in length, with straight or slightly outwardly convex sides; and a posterior cylindrical projection 0.5 length of aboral region, 0.30–0.40 (0.37) o.d. in diameter. Aboral end flattened, with rounded edge. Upper conical part homologous to lower bowl in Amplectella. Wall thick with faintly prismatic intermediate layer; rings twice as thick as wall between.

Five loricæ: L., total, 108–133 (122.0); to first ring, 10–13 (11.4); first to second ring, 20–32 (25.8); second to third ring, 16–20 (18.0); third to fourth ring, 15–23 (18.8); fourth ring to aboral end, 40–50 (44.0). D., oral, 39–43 (41.0); first ring, 45–51 (48.6); second ring, 46–55 (52.0); third ring, 48–55 (53.4); fourth ring, 49–58 (52.2); aboral end, 13–16 (15.0) μ.

At 6 stations, viz., at 3 each in Easter Island Eddy and Drift; at 70–75 (72.3)°; 8 loricæ.

XII. DICTYOCYSTIDÆ Hæckel emended

Codonellopsidæ, *partim*, K. and C., 1929, p. 67 (*Luminella* only).

Tintinnoinea with hyaline collar and reticular bowl; collar with one or two rows of regular, semicircular, squarish or rectangular windows, with or without a closing-pane; bowl hemispheroidal to ovoidal; aboral end without horn, rounded or pointed; wall of bowl entirely reticulated or with zoned fenestræ; no spiral structure; closing-apparatus present; eupelagic and marine only.

Differ from all other families in having one or two rows of semilunar or rectangular windows in collar.

Contains two genera: Dictyocysta Hæckel (29 species) and Luminella gen. nov. Kofoid and Campbell mss. (3 species). The former is characterized by large windows in high collar, with narrow vertical mullions and a thick circumoral style; the latter by low collar with minute semi-circular windows set in hyaline collar without rims, mullions, or style. Dictyocysta with oceanic distribution and Luminella coastal only. Luminella is based on *Stenosemella punctata* (Wailes) K. and C. (1929, p. 71, fig. 138) as type species. It includes also *L. inflata* and *pacifica* transferred from Stenosemella.

33. DICTYOCYSTA Ehrenberg emended Kofoid and Campbell

Dictyocystidæ with a lorica shaped like bowl of a goblet; with cylindrical collar with beams surrounding large fenestræ in one to several rows; bowl usually globose, often inflated, with rounded or pointed aboral region; no aboral horn; wall with primary, secondary, and tertiary reticulations, sometimes with included coccoliths; marine in all seas. Type species *Dictyocysta elegans* Ehrenberg emended

Kofoid and Campbell, from off Newfoundland, selected by Apstein (1915, p. 123) and also by us (1929).

Brandt (1907, pp. 52–63), in his discussion of Dictyocysta, expressed himself as much perplexed by the extraordinary variability of the loricæ and suggested the influence of cool and warm waters. The operation of this influence is abundantly brought out in our own discussion throughout the entire Tintinnoinea, though less evident in Dictyocysta than in other genera with more elongated loricæ. The extent to which availability, on the one hand, and selective utilization, on the other, determine the presence of coccoliths in the structure and patterning of the wall of the lorica is wholly unknown, though selective utilization generally is suggested by the fact that not all species at a given station utilize coccoliths and that some genera and species never utilize coccoliths in their loricæ.

Dictyocysta was established by Ehrenberg (1854a) as a genus of Polygastrica, including *Dictyocysta elegans*, *lepida*, *lepidæ β fundlandica*, and *acuminata*. The last of this list is accredited to Cyttarocylis by Brandt (1907), and the remainder are, at least in part, well recognized species. Hæckel (1873) included *D. cassis* in the genus, as well as *mitra*, *templum*, and *tiara*. The first is a Cyttarocylis and the last, as shown by Kofoid (1915), is probably based on a dried or otherwise distorted lorica of some large species of Dictyocysta. Brandt (1907) clearly defined and delimited the genus, though his subdivisions of the various species are somewhat confusing. It was apparently the first genus he dealt with in his investigation, and set the pattern for his later treatment of genera and species. In our *Conspectus* (1929) we endeavored to utilize general form and structural pattern primarily, and wall structure only as supplemental to these features. The species characters in this genus are perplexing on any basis.

The lorica of Dictyocysta represents one of the highest and most distinctive types of evolution attained in the Tintinnoinea. All species of the genus as here limited conform closely to the generic pattern. The outstanding structural feature is the collar with its row of 6–10 windows, or its double row of windows. These are without parallel or homologue elsewhere in the Tintinnoinea, except in the more primitive genus Luminella. The small fenestræ in the spiral lamina of the collar of Codonellopsis, notably *Cdps. ostenfeldi*, are perhaps attributable to included coccoliths. The windows in the collar of Dictyocysta, and presumably also of Luminella, have no such relations.

The only structures of morphological origin with similar regularity and structural relations which in any way approach the windows of Dictyocysta are found in the species described by Wailes (1925) as *Tintinnopsis punctata*. Later we (1929) divided this into two species, *punctata* and *inflata*, and transferred them to the genus Stenosemella, a genus characterized by the division of the lorica into a bowl and a low hyaline collar. These two species and Wailes's *Tps. punctata* forma *minor*, which we also transferred to Stenosemella, agree in having low, semicircular clear areas, or windows, at the base of the low collar. Other species of Stenosemella do not have these windows. The number, location, and relations of the windows of Luminella are comparable to those of Dictyocysta, but are much smaller, are structurally simpler, lacking rim, triangles, with connecting lines, and apparently the panes also, of Dictyocysta.

The case is somewhat different with respect to *Dictyocysta apiculata* Wailes, an aberrant species with a narrow collar with no openings and a series of elongate postnuchal fenestræ on the upper end of the bowl. Although described as a Dictyocysta, it is clearly of a different pattern and is more nearly related to Petalotricha. It differs from that genus in having a narrow, undivided collar, whereas in Petalotricha this structure consists of an oral shelf and a suboral cone. We have established the genus Wailesia for this unique species. Obviously, it is not derivable from, nor does it lead to, Dictyocysta, but belongs in the Petalotrichinæ.

The structurally unique species *Dictyocysta ovalis* Daday (1886, pp. 482, 496, pl. 25, fig. 14) has never been seen since Daday described it. It is a large species, 72 μ in length, with a much elongated bowl, as in *D. tiara*. The collar, however, is wholly unique in the genus Dictyocysta in that its upper rim is reflexed. It has the normal circumoral style and seven vertical mullions with squarish windows between them. If allowance is made for the height when the reflection is removed, the collar attains a height of about two-thirds of the usual proportions and size. Until this so-called species is rediscovered it may be regarded as probably based on an abnormally formed lorica. If and when rediscovered, it will of necessity form an isolated section of Dictyocysta, characterized by a low, recurved, but otherwise normally constructed collar, somewhat less differentiated, however, than in other species. It would be nearer to Luminella than are any of the other species of Dictyocysta because of the smaller size of the windows, but not referable to Luminella, as it has beams about its fenestræ.

Contains 29 species, of which 17 are recorded in Expedition material.

Of the 29 species 14 were new, and of these 10 are recorded from Expedition material. Subdivided into 3 series: the *mitra* series with two subordinate groups; the *mitra* group, including *mitra, fenestrata, obtusa, dilatata,* and *entzi;* and the *minor* group, including *minor, californiensis, pacifica, extensa,* and *spinosa;* the *occidentalis* series, including *occidentalis, lepida, reticulata, lata, mexicana, nidulus, grandis, tiara, polygonata,* and *duplex;* and the *mülleri* series, including *mülleri, inæqualis, ampla, elegans, speciosa, magna,* and *fundlandica.* One questionably valid species, *oralis* Daday, is unassigned, and one, *D. atlantica* Herdman, Thompson, and Scott, is a *nomen nudum.*

It is interesting to note that Kent (1882) states that Dictyocysta loricæ have been found in tertiary fossil beds, along with radiolarians and other Protozoa. This is the only record of fossil marine Tintinnoinea.

Dictyocysta ampla Kofoid and Campbell

Plate 27, fig. 5

Lorica fairly tall, moderately large, with high, well developed collar with 7 upper and 8–9 lower windows, rotund bowl longer than wide, postequatorial zone of 9–10 fenestræ, and rounded aboral end; 1.61–1.78 (1.69) o.d. Oral margin undulating, with 7 flat arches. Diameter of oral opening 0.56–0.62 (0.59) t.l., 0.75–0.79 (0.78) diameter of bowl, or 0.82–0.91 (0.88) nuchal diameter. Collar a tall segment of concave truncate cone (13°), 0.41–0.48 (0.45) t.l., 1.22–1.35 (1.26) o.d., 0.75–0.90 (0.78) diameter of bowl in length, with diameter at neck 1.11–1.22 (1.13) o.d. and at middle 0.96 o.d. Bowl hemispheroidal, with contour in main axis exceeding a hemisphere by 1.15 times its lateral radius; 0.53–0.55 (0.54) t.l., or 0.86–0.97 (0.92) o.d. in length; with equatorial diameter 1.27–1.33 (1.28) o.d., at 0.55 t.l. below oral margin. Aboral end hemispheroidal without point, except in few loricæ, with contracted, blunt tip. Wall of collar with two unequal rows of windows, first row with 7 rounded, inverted, subpentagonal polygons of approximately same size, 0.71 length of collar in length and 0.8 their own length in width; second with 7–9 windows forming posterior 0.29 of collar, less regular in shape and size than those of first row, rounded subpentagons with apices joined to vertical mullions between windows of first row, windows of second row alternating with those of first, half their size, but relatively wider. Windows of both rows surrounded by a moderately thick, raised, subuniform rim with minute, clear triangles in nodes with faint connecting lines in vertical and diagonal mullions.

Wall of bowl fenestrate, with 17 subequal triangular to hexagonal secondary polygons across widest level and 10 from nuchal margin to aboral end. Postequatorial row at 0.6 t.l. from oral margin, with 8–10 large, not uniform, hexagonal to rounded fenestræ, 3–10 times as large as those covering most of surface. Second postequatorial row at 0.8 t.l. from oral margin, with 4–6 less irregular fenestræ, half as large as those of major row. Fenestræ enclosed in narrow, subuniform, raised trabeculæ of minute hexagonal prismatic structure, and closed by panes made up of minute prisms. Animal with 16 membranelles.

Three loricæ: L., total, 57–68 (61.0); collar, 27–28 (27.3). D., oral, 33–38 (36.0); nuchal, 38–44 (41.0); bowl, 42–48 (46.0)μ.

At 3 stations in California Current; at 71–83 (76.6)°; 14 loricæ.

Dictyocysta californiensis Kofoid and Campbell

Plate 27, fig. 1

Lorica small, with denticulate oral margin, short cylindrical collar with 6 windows, stout globose bowl with 5 rows of large fenestræ, wide reticulated meshwork, and wide, pointed aboral end; 1.57–1.70 (1.65) o.d. Oral margin with 15–25 triangular teeth on upper margins of arches, each less than 1μ in length, subequidistant and subequal. Circumoral margin distinctly undulating, with 6 flattened arches, and no list. Diameter of oral opening 0.59–0.63 (0.60) t.l., 0.68–0.77 (0.74) diameter of bowl, or 0.87–0.94 (0.89) diameter of neck. Collar 0.25–0.32 (0.29) t.l., 0.34–0.45 (0.39) length of bowl, or 0.47 o.d. in length; subcylindrical or a truncate segment of a convex cone (6°). Nuchal diameter equal to or slightly greater than oral. Bowl stout, broadly ovoidal, 0.71–0.74 (0.72) t.l., or 1.14–1.27 (1.19) o.d. in length. Upper bowl a segment of a truncate, convex cone (37°), with a length of 0.17 t.l., or 0.27 o.d., with equatorial diameter of 1.15–1.48 (1.36) o.d. at 0.44 t.l. from oral margin; lower bowl hemispheroidal, completely filling contour of a hemisphere except distally, where for 0.22 of radius it is a flattened inverted cone of 130°, with basal diameter equalling radius of bowl at equator. Aboral tip bluntly rounded. Collar with single row of 6, rarely 7, squarish windows, noticeably more rounded at corners than in related species, subuniform in size and extent, separated by subuniform, thick (0.05 o.d.) vertical mullions. Circumoral style thin, horizontal. Transverse mullion very wide. Each window encircled by a narrow rim separated from adjacent ones by narrow lines with triangles at upper nodes only. Bowl with 5 unequal rows of

unequal fenestræ containing, respectively, 10–12, 13–14, 13–14, and 7–9 fenestræ, with terminal cluster of 4–7 small, less regular ones. First 2 rows uninterrupted, with quite uniform, subequal, and subcircular fenestræ. Third and fourth rows with fenestræ 0.50–0.75 diameter of fenestræ of anterior rows, less regular in distribution. Terminal cluster irregular, less than a fourth as large as those in first row. Meshwork around fenestræ heavy, with an average width of 0.06 o.d., filling entire space between fenestræ. Rims of trabeculæ only feebly developed, filled with coarse reticulum different from primary prisms of posterior end of bowl of *minor* and *pacifica*, their uniformity and optical qualities suggestive of presence of a minute coccolith in each element, but highest magnification and best definition did not reveal in these areas any coccolith structure. These small areas, each about 1μ in diameter, crowd the trabeculæ which are noticeably wider in this species and can be traced into bases of vertical mullions between windows but not beyond. Windows and fenestræ all closed by delicate hyaline panes.

Four loricæ: L., total, 44–51 (46.8); collar, 13–15 (13.5); bowl, 32–38 (33.8). D., oral, 27–30 (28.3); nuchal, 31–32 (31.8); bowl, 37–40 (38.5)μ.

At 2 stations in California Current; at 69–83°; 10 loricæ.

Dictyocysta dilatata Brandt

Lorica small, with flaring collar, deep nuchal constriction, small bowl, and pointed aboral end; 1.40–1.85 (1.60) o.d. Oral margin undulating, surmounted by low, continuous, hyaline circumoral list with 8 flattened arches. Diameter of oral opening 0.60–0.71 t.l., or 0.84–1.00 diameter of bowl. Collar a segment of an inverted, truncate cone (15°), 0.24–0.31 (0.24) t.l., or 0.33–0.47 (0.40) o.d. in length, laterally concave. Nuchal diameter 0.88–1.02 (0.95) o.d. Bowl elongate, ratio of its size to that of collar relatively small as compared with that of other species; 0.77 t.l., or 1.15–1.21 o.d. in length; subovoidal in contour below nuchal constriction, with length 1.15 equatorial or greatest diameter located midway of lorica and about equal to oral diameter. Upper bowl a slightly convex, truncated cone of 15–21°, 0.33 length of bowl. Lower bowl contracted acorn-shaped, extending beyond limits of hemisphere by about 0.33 of radius. Aboral end with short, rounded, subconical (90°) projecting tip 0.02 t.l. Collar with 8 subrectangular, subequal closed windows with

rounded corners, each surrounded by a relatively heavy, entire, raised rim. Vertical mullions stout, subequal. Entire bowl fenestrate with six unequal rows of unequal fenestræ. First row with 10 rounded subangular fenestræ. Second equatorial row with 12 rather unequal fenestræ of subcircular shape approximately half the size of those above. Third row with 10 fenestræ comparable in size and shape to those of second row. Fourth row with 6 fenestræ 0.75 diameter of first row, less regular and more often ellipsoidal in form. Fifth row with 7–8 tiny fenestræ less than 0.25 size of row above. Sixth row with 4 fenestræ like those of fifth row. All fenestræ enclosed in a denser, thick, raised, uniform meshwork of minutely reticulate prismatic trabeculæ, with a thin, homogeneous marginal rim surrounding each pane; each closed by a hyaline pane composed of minute rounded prisms, while those of the trabeculæ are mostly hexagonal. Wall very thin except where increased in trabeculæ.

Six loricæ: L., total, 59–65 (61.8); collar, 14–20 (15.3). D., oral, 36–42 (38.6); nuchal, 33–38 (36.0); bowl, 41–43 (42.3) μ.

At 4 stations, viz., at 2, 1, and 1, respectively, in California and Peruvian currents and Drift; at 68–71 (69)°; 6 loricæ.

Dictyocysta duplex Brandt emended Kofoid and Campbell

Plate 26, figs. 6, 7

Lorica rather large, stout; collar tall, with row of 7–9 windows; bowl subglobular, with edges of fenestræ double-margined; 1.63–1.78 (1.73) o.d. Oral margin undulating, with 7–9 short, well elevated arches with low, continuous, hyaline circumoral list. Diameter of oral opening 0.54–0.61 (0.58) t.l., 0.94–1.05 (0.99) nuchal diameter, or 0.72–0.89 (0.78) diameter of bowl. Collar tall, 0.33–0.39 (0.37) t.l., 0.50–0.64 (0.59) length of bowl, or 0.60–0.70 (0.65) o.d. in length; either subcylindrical, or a convex inverted, truncate cone (8–15°). Vertical mullions bowed out. Nuchal diameter 0.95–1.06 (1.01) o.d. Bowl subglobular, 0.61–0.67 (0.63) t.l., or 1.00–1.19 (1.09) o.d. in length. Upper bowl segment of convex cone of 60°, not over 0.25 o.d. in length. Equatorial diameter 1.12–1.38 (1.25) o.d., at 0.5 t.l. below oral margin. Upper 0.5 of lower bowl segment of convex inverted truncate cone (40°) with lower diameter equal to oral. Lower half contracting in a low, very convex, inverted cone of 90–100°, 0.3 o.d. in length. Aboral end with a slight tendency to a broadly rounded, blunt apex. In Brandt's figure (pl. 2, fig. 9) the bowl is more globular, exceeding con-

tour of a hemisphere by 1.18 of its lateral radius. Wall of collar with one row of 7–9 tall, rectangular windows with narrowly rounded corners, with length 1.2–2.1 times their width, the ratio depending upon number of windows in row. Vertical mullions and circumoral style equal in width and rather narrow. Rim around oral opening and windows clearly defined. Triangles at nodes, especially in style and middle line down each vertical mullion, clearly defined. Upper triangles filled with minute circular areas, those below invaded by mesh of bowl. All windows closed by delicate hyaline panes.

In hauls from cold-water region off Callaõ we find loricæ showing characteristic double wall of bowl figured by Brandt, with form and proportions of *tiara*, found in same hauls, and in a few loricæ with duplex structure only in parts of bowl. Judging from Brandt's figures, it might be inferred that the loricæ were coccolith-bearers, were it not for the interlacing circles and the thinness of the wall, which seem to preclude the only known circular coccoliths (*Syracosphæra apsteini*) of diameter and form similar to these areas of the loricæ. Lohmann (1912a), who found this species in the Mediterranean, reports its surface covered by *Coccolithophora wallichi*, *C. pelagica*, and *C. leptopora*. With the loss of the coccoliths, his loricæ have a uniform, non-duplex reticulum. Careful scrutiny of loricæ in our collections showing duplex structure shows that this appearance is probably due to overlapping, and the suggestion that this peculiar appearance is due to the inclusion of coccoliths is strongly reenforced, though the included structures probably belong to some as yet unknown or imperfectly described and very variable species. The fact that *Codonella diomedæ* and other species of Codonella and Codonaria in the same collections with the "duplex" loricæ of *Dictyocysta duplex* also exhibit a similar duplex wall is suggestive of a coccolith in the common food supply of both.

Fenestration of our loricæ varies greatly, from a pattern in which a narrow zone of duplex areas lies anterior to the major row, to one in which nearly the whole bowl from collar to apex is covered by subuniform ones. Evidences of a graduated substitution of a broad equatorial zone 4–6 duplex fenestræ in width for the major row appear in our material. Some of the smaller fenestræ found anterior and especially posterior to this zone are also duplex, but rarely are all of this form. We are not convinced that *duplex* belongs in the same category as the other species of Dictyocysta. Its peculiarities appear to result from a physiological factor such as selective feeding, or an ecological one such as a selected habitat in a particular coccolith zone which may differ from those which result in the other structural differentiations, such

as form and proportions of lorica and fenestration of wall, which characterize other species of the genus.

Seven loricæ: L., total, 57–72 (64.7); collar, 21–27 (24.1); bowl, 35–44 (40.7). D., oral, 35–39 (37.7); bowl, 44–51 (46.9); large duplex fenestræ, 6–9 μ.

At 12 stations, viz., at 1, 6, and 5, respectively, in Panamic Area, Peruvian Current and Drift; at 66–72 (71.3)°; 95 loricæ.

Dictyocysta fenestrata Kofoid and Campbell

Plate 26, fig. 10

Lorica quite stout, with collar slightly set off by shoulder from bowl; windows wide; bowl coarsely and sometimes irregularly fenestrate; aboral end hemispherical; 1.24 o.d. Oral margin deeply undulating, with 6–7 (8) flattened arches. No circumoral list, no spinules. Diameter of oral opening 0.8 t.l., 1.08–1.12 diameters of bowl, or 0.96–1.05 nuchal diameters. Collar set off from bowl by sloping shoulder and by lower edges of its large windows; 0.36–0.40 t.l., 0.57–0.68 length of bowl, or 0.45–0.50 o.d. in length, a truncate segment of an inverted cone (10°), with convex sides. In one lorica (Plate 26, fig. 10), perhaps distorted, cone (15°) is not inverted. Nuchal diameter in normal lorica 1.05 o.d. Bowl rotund, below equator almost a perfect hemisphere, 0.60–0.64 t.l., or 0.76–0.80 o.d. in length; expanding below neck for less than 0.10–0.14 t.l. as short segment of cone (32°), with basal or greatest diameter (1.08–1.12 o.d.) 0.5 t.l. from oral margin. Aboral end broadly rounded, with no point. Wall of entire lorica coarsely fenestrate. Collar typically with six rectangular windows, 1.12 times wider than long, with rounded corners. In one lorica figured (Plate 26, fig. 10), two adjacent windows deformed by invasion of a fenestra from bowl, and all windows compressed so that they are longer than wide, with length 1.5 width. Windows surrounded by a heavy raised framework with thick vertical mullions, transverse circumoral style relatively very light. In the abnormal lorica mullions subuniformly twisted a little (15°); closed by very delicate, transparent, hyaline panes; bowl with four rows of unequal fenestræ, anterior two rows large, quite irregular in outline, and with 9–10 and 9–11 fenestræ, respectively, with several minute triangular to quadrangular openings intercalated locally in nodes. Two aboral rows with 9 and 7 subuniform, rather irregular fenestræ. Aboral 0.3 of bowl of abnormal lorica with a cluster of 18 small fenestræ roughly in two rows but irregular in their

distribution, mostly triangular or quadrangular in shape, and a fourth as wide as fenestræ in subnuchal rows. All fenestræ on bowl closed by a translucent membrane. Wall with maximum thickness across trabeculæ.

Two loricæ: L., total, 50–52; collar, 18–21; bowl, 31–32. D., oral, 40–42; nuchal, 38–45; bowl, 43–47 μ.

At 3 stations, viz., at 1 and 2, respectively, in Peruvian Current and Drift; at 68–75 (71.7)°; 3 loricæ.

Dictyocysta lata Kofoid and Campbell

Lorica short and wide, with short collar with 8 long windows; bowl much wider than long, with one row of equatorial or post-equatorial fenestræ; very broadly rounded aboral end; 1.57 o.d. Oral margin undulating, with 8 flat arches with no circumoral list. Diameter of oral opening 0.64 t.l., 0.69 diameter of bowl, or 0.84 nuchal diameter. Collar erect, subcylindrical, with no taper or expansion beyond that produced by slightly concave vertical mullions, 0.35 t.l., 0.53 length of bowl, or 0.55 o.d. in length, with diameter at middle of 1.1 o.d. Nuchal diameter 1.18 o.d. Bowl 0.67 t.l., or 1.05 o.d. in length, made up of two unequal regions; a rather abrupt shoulder, not shown in Brandt's lorica (pl. 4, fig. 1), since panes of windows are not drawn, but in our lorica a truncated segment of a cone of 63°, 0.09 t.l. or 0.16 o.d. in length; bowl hemispherical below, with greatest diameter 1.45 o.d. at 0.53 t.l. below oral margin. Aboral end broadly rounded, without point. Framework of collar exceptionally delicate in structure, containing a single row of 8 tall, rectangular, subequal windows with narrowly rounded corners. Vertical mullions very thin, slightly convex, with very short terminal flares above and below, quite hyaline, and seemingly lacking prismatic structure. Circumoral style of like width, only faintly arched. Windows apparently lacking panes, encircled by a minute, hyaline rim inside frame; twice as long as wide, or nearly so, with their rounded, concave lower ends projecting into bowl. Wall of bowl reticulated with 27–30 subequal, quadrangular to hexagonal, secondary polygons across widest level, and 16–25 from neck to aboral end. One well defined row of 6–9 large postequatorial fenestræ, with major axis 0.3–0.4 o.d. in length, and width 0.20–0.29. A few smaller fenestræ scattered among secondary polygons, less than 0.25 of size of large ones, forming an incomplete anterior row of 10, with several below major row; all closed by hyaline panes. Wall of

bowl made up of single layer of rectangular, subequal prismatic polygons.

L., total, 60; collar, 21. D., oral, 38; nuchal, 45; bowl, 55μ.

At 2 stations in Peruvian Current; at 68°; 2 loricæ.

Dictyocysta lepida Ehrenberg emended Kofoid and Campbell

D. lepida, Hofker, 1931b, *partim*, pp. 382–384, fig. 78 (for fig. 76 see *D. reticulata*, and for fig. 77 see *D. mexicana*).

Lorica moderately stout and rather large; collar with 6–7 windows; bowl low, acorn-shaped, with pre-equatorial, equatorial, and posterior rows of fenestræ; aboral region subconical, and aboral point bluntly rounded; 1.48–1.80 (1.58) o.d. Oral margin undulating, with 6 or 7 flat arches, surmounted by narrow, hyaline circumoral list. Oral opening 0.56–0.67 (0.63) t.l., or 0.88–1.05 (0.94) nuchal diameter in diameter. Collar 0.41–0.47 (0.44) t.l., 0.70–0.87 (0.77) length of bowl, or 0.63–0.75 (0.70) o.d. in length; convex subcylindrical, increasing in diameter aborally, sometimes truncate conical (12°), rarely inverted truncate conical (20°). Nuchal diameter 0.95–1.15 (1.07) o.d. Bowl low, acorn-shaped, 0.55–0.59 (0.57) t.l., or 0.81–1.06 (0.93) o.d. in length, subdivided by changes in lateral contour into three unequal regions; anteriorly a short truncate segment of a slightly convex cone (43–62°), 0.13–0.16 t.l., or 0.19 o.d. in length, with basal or equatorial diameter 1.12–1.43 (1.29) o.d., at 0.55 t.l. from oral margin; second subdivision an inverted truncate segment of locally irregular convex cone (30–40°), 0.28–0.33 t.l., or 0.40–0.42 o.d. in length; third subdivision a rather variable, inverted, quite convex cone (115–125°), 0.13–0.20 t.l., 0.16–0.31 o.d., or 0.42–0.67 its lateral radius in length, with contour locally irregular, or concave, and asymmetrical, as though structurally weak and liable to deformation. Aboral end variable, almost always bluntly pointed, never acuminate, sometimes flattened. Collar with 6–7 windows, 0.6–0.7 their length in width, rectangular and with rounded corners. Vertical mullions and circumoral style quite narrow and subequal. Mullions not greatly flaring at ends. A narrow vein along circumoral margin and around each window. Triangles at nodes small, and vertical lines in mullions scarcely visible. Rims with a fine, punctate structure. Windows closed by delicate translucent panes. Wall of bowl, except for fenestræ, filled with small subuniform polygonal areas extending upward upon lower ends of mullions, 25–30 across neck, and 16–20 from neck to aboral end; mainly subcircular to hexagonal in shape, and surrounded

by raised marginal mesh of delicate reticulation. Fenestration in 3 rows. Pre-equatorial of 10–40 variable, irregularly grouped, rounded secondary fenestræ; equatorial of 6–7 larger irregularly subcircular to elongate ovoidal major fenestræ, variable in size, the longest 0.25 o.d.; and a posterior of 8 fenestræ in some loricæ. Coccoliths of *Umbilicosphæra mirabilis* in anterior row of a lorica from Sta. 4667. Regularity and structure of interfenestral reticulations suggest inclusion of a small unidentified coccolith. Fine primary prismatic structure clearly evident in wall of bowl.

Four loricæ: L., total, 55–63 (59.5); collar, 26–27 (26.5); bowl, 30–37 (34.3). D., oral, 35–43 (37.8); nuchal, 40–41 (40.3); bowl, 48–50 (49.0) μ.

At 15 stations, viz., at 1, 12 and 2 respectively, in Peruvian Current, Panamic Area, and Drift; at 66–80 (69.6)°; 45 loricæ.

Dictyocysta mexicana Kofoid and Campbell

Plate 26, figs. 1, 4

D. lepida, partim, Hofker, 1931b, pp. 382–384, fig. 77 (for fig. 76 see *D. reticulata*, and for fig. 78 see *D. lepida*).

Lorica rather large, elongated, with elongated collar with 7 windows, wide shoulder, subangular bowl, emergent aboral point, one preequatorial row of small secondary fields and a postequatorial row of major fenestræ; 1.44–1.72 (1.56) o.d. Oral margin decidedly undulating, with 7 elevated arches, and thin, hyaline, circumoral list. Oral opening 0.59–0.69 (0.64) t.l., 0.93–1.05 (0.97) nuchal diameter, or 0.77–0.84 (0.81) diameter of bowl in diameter. Collar 0.39–0.54 (0.44) t.l., 0.64–0.90 (0.78) length of bowl, or 0.66–0.71 (0.69) o.d. in length, an inverted truncate cone (7°), or subcylindrical with a little lateral convexity. Nuchal diameter 0.95–1.08 (1.03) o.d. Bowl subangular, 0.54–0.61 (0.56) t.l., or 0.78–1.01 (0.88) o.d. in length, made up of three unequal segments marked by sharp changes in lateral contour, forming a seven-sided figure in optical section. First, the shoulder region, a short, truncate segment of a cone (80°) with straight sides, 0.11 t.l., or 0.19 o.d. in length, with greatest diameter (1.19–1.30 [1.24] o.d.) at its base, 0.48 t.l. below oral margin. Second section an inverted truncate cone (35°), 0.27 t.l., or 0.45 o.d. in length, with slightly convex sides, decreasing to an aboral diameter of 0.89 o.d. Third segment an inverted, rather wide, quite short cone (126°), 0.14 t.l., 0.22 o.d., or 0.5 its own horizontal radius in length. Aboral end

acuminate, with a tiny, very wide projecting cone of 99°. Tip blunt. Wall of collar with one row of 7 tall, rectangular windows, with length 1.40–1.77 (1.59) of their width, and narrowly rounded corners. Vertical mullions and circumoral style very slender and often considerably bowed outwardly. In one lorica (Plate 26, fig. 4) the windows are twisted toward right 17° from vertical. Vertical mullions cylindrical, except in flaring ends; triangles at nodes minute, and connecting line down the outer face of each mullion faint. Mullions show no fine prismatic structure. No panes seen in windows. Wall of bowl distinctly reticular and entirely filled, save for fenestræ and secondary fields, with fine, prevailingly triangular to hexagonal polygonal fields, 2–5 μ across, with larger ones more or less confined to anterior half of bowl; 30 across bowl and 22 from nuchal line to aboral end, with raised marginal meshwork about them. Two rows of larger areas; first at level of shoulder, containing 26–30 secondary fields, rounded or quadrangular to hexagonal in shape, about 0.07 o.d. in longest axis; second postequatorial with 9–10, much more prominent, large fenestræ, subcircular to rounded quadrangular, 0.23 o.d. in longest axis and 0.18 or more in width, with main axis often inclining to right 30° from vertical. An odd fenestra of large size now and then occurs in posterior section of bowl. All fenestræ closed by delicate hyaline panes.

Five loricæ: L., total, 57–66 (63.3); collar, 24–28 (26.2); bowl, 28–39 (33.6). D., oral, 36–40 (38.2); nuchal, 38–40 (39.3); bowl, 43–52 (47.4) μ.

At 10 stations, viz., at 3, 4, 1, and 2, respectively, in California, Mexican, and Peruvian currents and Panamic Area; at 69–84 (79.2)°; 18 loricæ.

Dictyocysta minor Jörgensen

Plate 27, fig. 9

Lorica small, with flaring collar with six windows, globose bowl with five irregular rows of fenestræ, and bluntly pointed aboral end; 1.53–1.73 (1.62) o.d. Oral margin with 6 flattened arches, no circumoral list, 18–20 minute vertical points less than 1 μ in length, more or less equidistant, or closely approximated in groups of three or four on top of arches rather than between them. Diameter of oral opening 0.57–0.65 (0.62) t.l., 0.90–1.03 (0.97) nuchal diameter, or 0.73–0.86 (0.79) diameter of bowl. Collar 0.26–0.28 (0.27) t.l., 0.35–0.38 (0.37) length of bowl, or 0.37–0.47 (0.43) o.d. in length, a truncate segment of an inverted concave cone (14°), decreasing subsymmetri-

cally to 0.9 o.d. at its middle, increasing below at neck to 0.97–1.10 (1.03) o.d. Usual form an inverted truncated cone, but a few loricæ flare orally from neck, and others are subcylindrical, as shown by wide variation in diameter of neck. Bowl broadly ovoidal, 0.72–0.74 (0.73) t.l. or 1.13–1.27 (1.19) o.d. in length, anteriorly a truncate segment of a scarcely convex cone (38°) 0.21 t.l., or 0.3 o.d. in length; with equatorial diameter (1.16–1.36 [1.26] o.d.) located midway. Aboral region hemispheroidal, projecting beyond contour of a hemisphere aborally 0.15 of radius, with distal part very convex subconical. Aboral end pointed. Wall of entire lorica coarsely fenestrate. Collar with a row of 6 large, subrectangular, squarish, subuniform windows with slightly rounded corners; 0.8 of width in height, with upper edge 1.2 longer than lower, separated by subuniform, thick vertical mullions. Circumoral style flattened. Transverse mullion quite heavy, undulating or zigzag. Around each window a continuous rim, with width of 0.14 of window, and similar continuous but narrower suboral rim encircling oral margin; rims meeting along tops of arches and along sides, leaving minute, clear, inverted triangles at nodes. Fenestræ in three irregular rows on bowl, with 6–7, 10–11, and 12–13 fenestræ, respectively. First row with some fenestræ nearly as large and some only two-thirds as large as windows on collar, but subcircular. Second and third rows with smaller fenestræ, about half diameter of first row, and less regular in distribution. Terminal cluster of small fenestræ with rather lawless distribution in aboral 0.3 of bowl, and several interpolated fenestræ between regular members of second and third rows, ovoidal in shape. Heavy meshwork enclosing fenestræ filling entire interfenestral space around each fenestra, regardless of its size or row, leaving clear triangles at nodes. Windows and fenestræ all closed by delicate, clear panes. Closing-apparatus conical (96°), with 14 blades, with lower end at neck and pointed apex on a level with oral margin.

Five loricæ: L., total, 43–52 (47.0); collar, 12–14 (12.6). D., oral, 27–32 (29.0); nuchal, 28–31 (29.8); bowl, 35–38 (36.6) μ.

At 9 stations, viz., at 2, 1, 1, and 5, respectively, in California, and Peruvian currents, Galapagos Eddy, and Drift; at 67–76 (71.7)°; 25 loricæ.

Dictyocysta mitra Hæckel emended Kofoid and Campbell

Plate 27, fig. 8

Lorica mitre-shaped, relatively slender, lacking clear differentiation between collar and bowl, except for smaller number (6) of windows in

collar row, larger in size than fenestræ on bowl; with bowl coarsely fenestrated throughout with decreasing diameter in last two rows; with aboral end feebly pointed; 1.57–1.65 (1.62) o.d. Oral margin undulating, with 6–7 very flat arches surmounted by narrow, hyaline circumoral list. Diameter of oral opening 0.60–0.64 (0.61) t.l., or 0.86–1.14 (0.90) nuchal diameter. Collar flaring orally in an inverted truncate cone of 10–13°, with lower limit at level of lower edges of rounded subquadrangular windows; 0.22–0.26 (0.23) t.l., 0.28–0.41 (0.31) length of bowl, or 0.35–0.40 (0.38) o.d. in length. Nuchal diameter 0.83–0.92 (0.88) o.d. Bowl subovoidal in contour, widest (0.95–1.07 [1.01] o.d.) a little above its middle and a little below middle of lorica as a whole, 0.77 t.l., or 0.95–1.27 (1.24) o.d. in length. Upper bowl a segment of a cone 20–23°, with slightly convex sides, and lower bowl extended beyond contour of a hemisphere by not over 0.33 of its radius. Aboral region contracting to a cone of 130° in distalmost part. Aboral tip never acute, broadly rounded, or bluntly pointed. Wall of entire lorica coarsely fenestrate, more uniformly so than in other species. Collar with 6–7 squarish, subequal windows, with rounded corners. Each window surrounded by a heavy raised frame consisting of horizontal circumoral style arched over each window, vertical to subvertical subuniform lateral mullions, and lower horizontal mullions less regular in length and slope than upper style because of adjustments to first tier of fenestræ on bowl. Rims around windows and fenestræ with fine median line down middle terminating at each end in tiny triangular depression. Windows closed by transparent, hyaline panes. Bowl with 6–7 rows of large, subregular fenestræ, fewer in a row and smaller aborally below equator. First row below windows with 8–10 fenestræ, larger than those of other rows, subpentagonal or subquadrangular to somewhat rounded, and about as long as wide. Second row with 12 smaller fenestræ similar to, but less regular than those of first row. Third and fourth rows each with 10–11 fenestræ, more irregular in outline, smaller, and less uniform in size, with small fenestræ in, or adjacent to, these rows. Fifth and sixth rows with considerably smaller fenestræ, less regular in outline, quite variable in size, but always smaller than in rows above, with 8 and 6 fenestræ, respectively. Antapex with 8–12 distinctly smaller fenestræ in a terminal cluster. Odd fenestræ occur elsewhere in nodes of regular, subpolygonal meshwork. Trabeculæ with quite thick raised meshwork with triangular areas at nodes. Fenestræ all closed by a thin sheet of minutely prismatic material. Trabeculæ made up of coarser, more rounded prisms. Animal large, with 6 or 8 oval macro-

nuclei, each 4 by 6μ. Hofker (1931b) found 8 macronuclei and 2 micronuclei. Entz, Jr. (1908, pl. 5, fig. 9) shows a conical closing-apparatus of 4 blades on one side.

Six loricæ: L., total, 58–66 (61.0); collar, 13–15 (14.1). D., oral, 35–40 (37.5); bowl, 37–41 (38.0)μ.

First figured by Ehrenberg (1854c, pl. 35A, fig. 24d) as *D. elegans*. His lorica is 1.7 o.d. in length, lacks a distinction between collar and bowl, has one row of 9 windows, a row of large suboral fenestræ and two rows below, and a pointed, non-emergent aboral end. All of these features are characteristic of *mitra*. From his description and figure it is evident, as Brandt (1907) and Jörgensen (1924), whom we follow, point out, that Ehrenberg had both *elegans* and *mitra* in hand, and that his figure is *mitra*, though his description applies to *elegans*. The figures of Hæckel (1873), Daday (1886), Brandt (1906), Entz, Jr. (1908, 1909b), Biedermann (1893), and Hofker (1931b) are much more slender than ours, which are smaller and stouter than those from the Atlantic and Mediterranean.

In all subsequent investigations *mitra* has been included, or more or less confused, with *elegans* (see Brandt, 1907). Brandt's grounds for recognizing the validity of this species are the large numbers of individuals and the relatively small amplitude of variation of the species within its main area of occurrence. The divergent forms occur mainly on the margins of this area, where intermediates tending towards *elegans* are found, and in colder waters, where larger forms (Brandt's varieties *a* and *b*) appear.

The collections from the Pacific confirm Brandt's (1907) and Jörgensen's (1924) views as to the distinctness of this species. The strongest evidence for this arises from the fact that *elegans* does not occur in the area under our investigation, while *mitra* is widespread and fairly common throughout a large part of the Eastern Tropical Pacific.

The morphological evidences of the distinctness of *mitra* from *elegans* appear to be less pronounced in loricæ from the Pacific collections than in those of the Plankton Expedition in the Atlantic as figured by Brandt (1906). The greater part of the Eastern Tropical Pacific territory is occupied by a form which resembles Brandt's var. *c* (= *ampla* K. and C.) more than any of the other varieties he lists from the Atlantic. This is, moreover, of all his varieties, the most like *elegans*, except for our Pacific representative (*pacifica*), which is even more like *elegans* in some of its characters. This is indicated by the relatively less elongated lorica, the tendency toward reduction in the size of, and increase in the number and irregularity of, the fenestræ of the aboral end. These

tendencies attain, in some cases, a pattern of fenestration of the bowl which is strikingly like that in *elegans*.

This character of large, regular fenestration, which Brandt (1907) found to be diagnostic, even in his var. *c*, is much less dependable in our Pacific material. We are forced to utilize the sharper distinction of collar and bowl in *elegans*, as against its absence in *mitra*, and the additional structural characteristic involved in this feature, namely, the presence of two rows of large fenestræ on the collar of *elegans*, with a somewhat abruptly formed expansion of the bowl immediately beyond junction of collar and bowl, that is, behind the second row of fenestræ. In *mitra*, on the other hand, the constriction between the faintly separated collar and the expanding bowl lies between the first and second row of fenestræ, and the second row lies distinctly upon the bowl rather than in the collar. The oral rim of *elegans* in all its forms is free from spines, spinules, and serrations, but does, in some forms, have a thin, continuous marginal sheet, as described by Biedermann (1893). The two species are closely related, but intergradation was not detected.

At 20 stations, viz., at 2, 7, and 11, respectively, in California and Peruvian currents and Drift; at 66–79 (69.3)°; 47 loricæ. Type locality selected by us is Sta. Pl. 25 (Brandt, pl. 1, fig. 1) between the Florida and Labrador currents, a location approximating the probable source of Ehrenberg's original material.

Dictyocysta mülleri (Imhof) Jörgensen emended Kofoid and Campbell

Plate 27, fig. 2

Lorica small; collar with two subequal rows of windows, 6 windows in upper, and 8–10 in lower row, with slight constriction between rows; bowl subconical; pre-equatorial row of small fenestræ, a post-equatorial of larger ones, and scattered posterior fenestræ; bluntly pointed aboral end; 1.54–1.76 (1.68) o.d. Oral margin moderately undulating, with 6 low arches. Oral opening 0.57–0.65 (0.60) t.l., or 0.85–0.95 (0.91) nuchal diameter in diameter. Collar 0.46–0.49 (0.47) t.l., 0.73–0.82 (0.77) o.d., or 0.82–0.97 (0.84) length of bowl in length; forming a concave spool with low rims, formed of two unequal regions, the anterior an inverted, truncate segment of a concave cone (19°) 0.59 of collar, or 0.4 o.d. in length, and aboral diameter at maximum constriction 0.84 o.d. Second subdivision a short segment of a con-

cave truncate cone (32°) 0.41 length of collar, 0.28 o.d., or 0.7 of section above it, and aboral diameter of 1.05–1.18 (1.09) o.d. Bowl subconical, 0.52–0.57 (0.56) t.l., or 0.80–1.00 (0.92) o.d. in length, formed of two unequal regions. Upper bowl a short truncate section of a slightly convex cone (44°), 0.15 t.l., or 0.24 o.d. in length, with its aboral end the equator, 1.08–1.33 (1.25) o.d. in diameter, at 0.55 t.l. from oral margin. Lower bowl a wide, convex, inverted cone (78°), 0.45 t.l., 0.72 o.d., or 1.2 times its lateral radius in length. Aboral region contracting to a bluntly rounded point. Wall of collar with 6 squarish windows in first row, with arched sides and slightly rounded corners, and 8–10 subcircular to subpentagonal ones in second. The disproportionately small number of windows of first row as compared with second results in a crowding and outward flaring of the latter and in submedian constriction of collar. Circumoral style and all windows of both rows bordered by narrow rim, with tiny clear triangles at nodes between rims at tops of vertical mullions of upper row. Lines down middle of each mullion meeting an angle of a triangle or of a quadrilateral area with concave sides in zigzag transverse mullions encircling middle of collar. Lowermost transverse mullions lacking triangles, filled entirely with a fine alveolar mesh larger than primary prismatic structure, but not so large as the usual secondary type. Preequatorial row with 20 subrectangular fenestræ, with long axes inclined 25° to left, with rounded angles, subequal in size, and 0.3 size of windows of second row on collar. Postequatorial row of 9–12 large, subcircular major fenestræ, twice diameter of those of anterior row. Second postequatorial row of 8 somewhat smaller major fenestræ. Aboral 0.3 of bowl with an irregular cluster of 8–10 scattered fenestræ of still smaller size. Interfenestral space on bowl from its widest level downward covered by small, prevailingly triangular to hexagonal polygonal areas, 45 around bowl near equator, and 10 from end to end. Polygonal areas and fenestræ each surrounded by a meshwork of raised trabeculæ, and closed by a delicate hyaline pane. Surface reticulum made up of fine, hexagonal, primary prismatic structure. Closing-apparatus a truncate cone (67°) of 10 elongated quadrilateral blades with broad bases resting on inner face of lorica below second row of collar fenestræ, and narrower free ends converging and more or less overlapping in closing to form a blunt, centrally located apex below level of oral rim; blades thin hyaline structures, in optical appearance similar to the material of the lorica, but very thin, and without evident reticulations or prismatic structure, remaining in lorica after animal has disappeared.

At Sta. 4583, in a haul from 300–0 fms., a curious mass made up of three adhering loricæ of this species was found. The three loricæ were fastened together with their oral openings united in a fashion like a similar mass of *Stenosemella nivalis* also observed by us. This massing of loricæ with the oral apertures together suggests an abortive effort at conjugation, from which attempt the would-be conjugants were unable to free themselves, due to adhesiveness of the loricæ, not unlike the "stolen" collars of *Codonella cratera*, of which Entz, Jr. (1909a) makes much.

Eight loricæ: L., total, 58–63 (60.0); collar, 27–31 (28.1); bowl, 30–34 (33.4). D., oral, 33–39 (36.3); nuchal, 38–42 (39.8); bowl, 44–47 (45.4) μ.

At 4 stations in California Current; at 71–83 (74.7)°; 39 loricæ.

Dictyocysta occidentalis Kofoid and Campbell

Plate 26, fig. 2

Lorica small, stout; collar with 6 windows; bowl short, rotund, with 2–3 or more rows of postequatorial fenestræ, and hemispherical aboral region; 1.42–1.68 (1.58) o.d., or 1.31–1.41 diameters of bowl. Oral margin relatively deeply undulating, with 6 gently rounded arches surmounted by very narrow, hyaline, continuous circumoral list. Diameter of oral opening 0.59–0.70 (0.63) t.l., or 0.82–0.93 (0.85) diameter of bowl. Collar sharply set off from bowl by abrupt change in slope, 0.34 t.l., or 0.49 o.d., or 0.63 of length of bowl; rather short, nearly cylindrical. Bowl short and stout, 0.66 t.l., or 0.97 o.d. in length, with contour almost included within that of a sphere with its upper sixth removed, with length to lower edge of windows 0.83 of its greatest diameter (1.14–1.18 o.d.) located 0.86 o.d. below rim. Aboral region hemispheroidal. Aboral end without angulation. Wall of collar with 6, rarely 7, squarish windows, with height 1.1–1.2 or, rarely, 1.5 their width, narrower, 1.5–1.7 in collars with 7 windows; with rounded corners and convex sides. Vertical mullions very wide, up to 0.25 width of window in width, flaring at ends. Horizontal style and transverse mullion relatively narrower than vertical mullions. Rim around inside of windows very narrow, hyaline. Wall of bowl set off from that of collar by denser structure and slightly undulating anterior margin. Pre-equatorial region with many small, rounded, ovoidal, or ellipsoidal fenestræ, prevailingly irregularly rounded quadrangular to hexagonal in shape, subuniform in size, 24 across one face in 2–4 rows, with a

raised fretwork of narrow ridges around each. Large fenestræ confined to postequatorial region of bowl; major row slightly postequatorial, with 8–10 very large fenestræ; subcircular to rounded quadrangular in shape, about as wide as long, with vertical axis inclined as much as 25° to right, with unusually wide trabeculæ. Second row with 6–8 fenestræ, and a third usually present, with 5. All rows, especially posterior two, with smaller fenestræ interpolated or between larger ones, giving more or less irregularity to surface pattern. Fenestræ of two lower rows not over 0.5 diameter of those of major row, and of same shapes. Trabeculæ filling space between larger fenestræ, with a reticulation of secondary fields, ranging down in size to very tiny ones a little larger than primary structure. Often several sizes are found in one lorica, and sometimes there is a marked zonal arrangement with belt of larger fields behind collar and minute ones elsewhere. In a lorica from Sta. 4708 the interfenestral spaces were completely filled with coccoliths of *Pontosphæra hœckeli* and one from Sta. 4640 with *Coccolithophora wallichi* and *Syracosphæra pulchra*. Secondary reticulations of bowl made up of fine, rounded primary prisms, and mullions of collar filled with larger hexagons. Secondary reticulations enclose 6–15 rounded primary prisms. Windows and fenestræ all closed by a thin, translucent sheet of hyaline material. Closing-apparatus exceedingly hyaline, of 10 blades with asymmetrically rounded tips.

Ten loricæ: L., total, 55–62 (57.8). D., oral, 35–40 (36.4); bowl, 40–47 (42.7) μ.

At 16 stations, viz., at 3, 1, 3, 2, and 7, respectively, in California and Mexican currents, Panamic Area, Easter Island Eddy, and Drift; at 72–81 (74.6)°; 70 loricæ.

Dictyocysta pacifica Kofoid and Campbell

Plate 27, figs. 3, 4, 7

Lorica stout, rather small; collar with 7 windows; bowl subglobose, with 1–2 rows of pre-equatorial fenestræ and numerous smaller ones below equator on lower bowl; aboral end subconical; 1.34–1.79 (1.55) o.d. Oral margin undulating, with 7 flat arches, bearing 15–25 minute, erect, or flaring denticles, 2–4 scattered along top of circumoral style of each arch. Diameter of oral opening 0.56–0.74 (0.64) t.l., 1.00–1.13 (1.05) nuchal diameters, or 0.74–1.00 (0.87) diameter of bowl. Collar 0.23–0.27 (0.26) t.l., 0.30–0.39 (0.36) length of bowl, or 0.28–0.42 (0.33) o.d. in length; a truncate segment of an inverted cone (9–13°), concave laterally, expanding regularly to throat, with diameter of

0.89–1.00 (0.95) o.d. Bowl stout globose to very broadly ovoidal, 0.72–0.77 (0.73) t.l., or 0.79–1.25 (1.13) o.d. in length. Upper bowl a short segment of a convex truncate cone (26–27°), 0.19–0.25 t.l., or 0.25–0.42 o.d. in length, with greatest diameter (1.00–1.36 [1.15] o.d.) at 0.42–0.48 t.l. from oral margin. Aboral region pointed hemispheroidal, sometimes (Plate 27, fig. 4) slightly fuller than a hemisphere, but in more pointed loricæ (Plate 27, figs. 3, 7) laterally less than a hemisphere, and aborally subconical (123–135°), extending 0.18–0.20 of radius beyond limits of a hemisphere. Aboral end ranging from a mere trace of a broadly rounded point to a blunt angle, but never emergent. Wall of entire lorica differentially fenestrated. Collar with a single row of seven subrectangular windows with slightly rounded corners, subuniform in size and separated from each other by subuniform, slender vertical mullions. Circumoral style relatively quite thin and regularly arched. Transverse mullions relatively wide and regular. Each window with usual rim with clear triangles at nodes. Rim with width of 0.12 of window. Bowl with one pre-equatorial row of 10 unequal subcircular fenestræ, fairly regular in size and distribution. Second, or equatorial, row with 12–13 unequal, asymmetrical fenestræ, with occasional tiny ones interpolated in supporting trabeculæ, lacking in one lorica (Plate 27, fig. 4). Fenestræ of both rows surrounded by optically dark trabeculæ unlike those surrounding windows, usually enclosing a zone of minute reticulations, unlike primary reticulations in larger size and greater irregularity. Posterior half of bowl with few fairly large, irregularly distributed, often grouped fenestræ about as large as those of second row. Remaining portion of bowl filled with a reticulum of small polygons, 15 across bowl and 8–10 from equator to aboral end, mostly hexagonal and fairly uniform in size, forming a distinct aboral zone. Coccoliths of *Umbilicosphæra mirabilis* found on posterior half of loricæ at Sta. 4666 filling reticular areas of interfenestral regions. All windows and fenestræ closed by hyaline panes. At Sta. 4713 a pair of loricæ in oral apposition, as if in conjugation, was seen, each with large animal filling 0.6 of cavity, one with 8 ellipsoidal macronuclei, each 4 by 6 μ, arranged with 7 in one group and 1 in center of animal; in the other animal 6 scattered macronuclei in three pairs, as if daughters. Micronuclei could not be found in material stained in borax-carmine. Closing-apparatus with 15 blades attached to lorica after animal has disappeared, a low cone with apex at level of oral margin, and base spreading to attachment at level of throat.

Ten loricæ: L., total, 43–53 (49.3); collar, 12–14 (12.9); bowl, 31–40 (35.9). D., oral, 28–36 (31.7); neck, 28–32 (30.2); bowl, 33–38 (36.4) μ.

At 29 stations, viz., at 1, 3, 8, 3, 2, and 12, respectively, in California, Mexican, and Peruvian currents, Panamic Area, Galapagos Eddy, and Drift; at 67–85 (74.03)°; 61 loricæ.

Dictyocysta polygonata Kofoid and Campbell

Plate 26, fig. 8

Lorica rather small, stout; collar with 6–8 windows; bowl globose; no large fenestræ; wall with reticulum of many small, rounded polygons; no aboral point; 1.50–1.77 (1.61) o.d. Oral margin with 6–8 feebly developed arches surmounted by a delicate, hyaline circumoral list. Diameter of oral opening 0.56–0.67 (0.62) t.l., 1.00–1.11 (1.04) nuchal diameters, or 0.77–0.89 (0.82) greatest diameter of bowl. Collar 0.36–0.41 (0.38) t.l., 0.57–0.69 (0.60) length of bowl, or 0.57–0.69 (0.62) o.d. in length; an inverted truncate segment of a convex cone (8–15°). Nuchal diameter 0.89–1.00 (0.96) o.d. Vertical mullions much bowed outwardly. Bowl subglobular, 0.59–0.63 (0.62) t.l., or 1.45–1.75 (1.61) o.d. in length; spheroidal, with exception of slight conical flare below collar. Wall of collar with 6–8, usually 7, quite regular rectangular windows, with width 0.57 their length. Circumoral style thicker than vertical mullions. Thin rim around oral aperture and each window. Clear triangles at upper nodes minute, those at lower nodes occluded. Vertical connecting lines on mullions very faint. Lower transverse mullion almost straight. Wall of bowl made up of small polygonal fields, 30–45 around equator and 10–16 from end to end, prevailingly triangular to hexagonal in shape with sharp angles, varying 30% in size; enclosed in a raised reticulum of uniformly thin trabeculæ and all closed by delicate hyaline panes. No large fenestræ on bowl, with exception of a lorica from Sta. 4594 with not more than two on one face of bowl, not in a definite row. No primary prisms and no coccoliths observed. Animal large, filling upper 0.6 of cavity. Closing-apparatus truncate conical (68°), of 10 blades originating at neck and extending for 0.67 of collar.

Four loricæ: L., total, 54–62 (58.3); collar, 20–24 (22.3); bowl, 32–39 (36.0). D., oral, 35–39 (36.3); nuchal, 33–36 (34.8); bowl, 42–47 (44.5) μ.

At 10 stations, viz., at 1, 5, 2, 1, and 1, respectively, in Mexican and Peruvian currents, Panamic Area, Galapagos Eddy, and Drift; at 68–84 (72.9)°; 13 loricæ.

Dictyocysta reticulata Kofoid and Campbell

Plate 26, figs. 3, 5

Non *D. templum*, Gräf, 1909, p. 148, fig. [6]e (see *D. nidulus*).
D. lepida, partim, Hofker, 1931b, pp. 382–384, fig. 76 (for fig. 77 see *D. mexicana*, and for fig. 78 see *D. lepida*).

Lorica small; collar with 6–8 windows; bowl angular, with one row of postequatorial fenestræ, uniform, regular polygonal areas elsewhere and bluntly pointed aboral end; 1.43–1.82 (1.56) o.d., or 1.21–1.44 diameters of bowl. Oral margin quite undulating, with 6–8, usually 7, fairly well developed arches, surmounted by a narrow, hyaline circumoral list. Diameter of oral opening 0.55–0.69 (0.64) t.l., or 0.80–0.93 (0.83) diameter of bowl. Collar an inverted, truncate segment of a cone (3–5°), 0.31–0.35 (0.32) t.l., or 0.44–0.50 (0.48) o.d. in length. Nuchal diameter 0.79–0.96 (0.88) o.d. Bowl low, acorn-shaped, with an abrupt shoulder 0.68–0.69 (0.68) t.l., or 0.96–1.04 (0.98) o.d. in length; made up of three unequal regions; an upper short segment of a truncate cone (60–66°) constituting the abrupt, sloping shoulder, 0.11–0.14 t.l., or 0.17–0.19 o.d. in length, with straight or slightly convex sides. Equatorial diameter 1.08–1.27 (1.20) o.d., or 0.75–0.86 (0.77) t.l., at 0.43–0.51 t.l. from oral margin. Second region a longer, inverted, truncate segment of a cone (36–53°), 0.35–0.43 t.l., or 0.50–0.67 o.d. in length, with aboral diameter of 0.73–0.83 o.d. Aboral region a short, wide, inverted cone (100–118°), 0.11–0.22 t.l., or 0.16–0.31 o.d. in length, usually with straight sides. Aboral end angular, with bluntly pointed tip. Wall of collar with 7, rarely 8, and still less frequently 6, windows, with height 1.5 times their width, relatively narrower in collars with 8 and wider in those with 6. This species distinguished by a single row of postequatorial fenestræ immediately below equator with same number of fenestræ as windows, or 1 or 2 more; usually rounded, varying in size in different loricæ, and even in same one; some loricæ with several fenestræ forming a partial posterior row. Remainder of wall with quite uniform, polygonal secondary fields, varying in diameter in different loricæ. Primary prismatic structure exceedingly faint, appearing in nodes of collar beams and very faintly in panes, but not demonstrable in polygonal fields, frequently including coccoliths, in rare cases completely filling whole wall of bowl outside of major fenestræ and even appearing on panes; several genera of coccoliths being represented in a single lorica. Their determination difficult because of their inclusion in matrix of lorica, whose refractive index

does not materially differ from theirs; following species recognized: *Coccosphæra pelagica* at Sta. 4615, and 4724 on same lorica with Syracosphæra; *Pontosphæra huxleyi* at Sta. 4615, 4635, 4638; and *Pontosphæra hæckeli* at Sta. 4708. Animal filling over 0.5 of cavity of bowl, with 4 pairs of oval macronuclei, each about 4 by 8 μ. Hofker (1931b) finds 2 micronuclei. Closing-apparatus conical, made up of 9 unequal blades, each truncate at distal end.

Ten loricæ: L., total, 52–62 (56.7). D., oral, 34–39 (36.4); bowl, 40–47 (43.8) μ.

At 79 stations, viz., at 3, 6, 16, 2, 2, 1, 15, 1, 2, and 31, respectively, in California, Mexican, Peruvian, South Equatorial, Equatorial Counter, and North Equatorial currents, Panamic Area, Easter Island and Galapagos eddies, and Drift; at 66–84 (72.9)°; 638 loricæ.

Dictyocysta spinosa Kofoid and Campbell

Plate 27, fig. 6

Lorica small, stout, with spinules; collar with 6–7 windows; stout bowl with 6 rows of graduated fenestræ and pointed or rounded aboral end; 1.31–1.42 (1.38) o.d. Oral margin with 8–12 (10) large, subequidistant, narrow, conical (10°) spinules, 0.3–0.5 height of windows in length, not uniform in either length or angle on same or different individuals, varying in slope from horizontal to as much as 45° above horizontal; some loricæ (Plate 27, fig. 6) with one spinule near middle of each arch. Oral margin undulating, with 6 or 7 flattened arches, without circumoral list. Diameter of oral opening 0.70–0.76 (0.72) t.l., 0.83–0.92 (0.88) diameter of bowl, or 1.03–1.07 (1.04) nuchal diameters. Collar 0.27–0.37 (0.32) t.l., 0.36–0.48 (0.41) length of bowl, or 0.39 o.d. in length; a truncate segment of an inverted cone (22°), with concave sides, expanding to 0.91–0.97 (0.96) o.d. at neck. Bowl stout, 0.67–0.73 (0.71) t.l., or 0.90–1.06 (0.98) o.d. in length; quite globose, with length to nuchal level 0.79–0.94 (0.87) its diameter. Upper bowl a segment of a convex cone of 25–28°, 0.4–0.5 o.d. in length, with equatorial diameter 1.09–1.10 o.d. located at 0.43–0.50 t.l. below oral margin. Aboral region ranges from an almost perfect hemisphere to a broadly subconical (at the tip, 130°) contour with an extension of radius by 0.1 its length. Aboral tip either not differentiated or barely developed as a non-emergent, bluntly rounded point. Wall of entire lorica coarsely fenestrate. Collar with a single row of 6–7 windows, subuniform, subrectangular, a little wider than long, with slightly

rounded corners, and separated by subuniform, vertical mullions widened at either end. Circumoral style narrow. Transverse mullion half again as heavy and irregular in thickness and slope. Rim continuous around each window, quite wide, optically differentiated. Circumoral band of like structure encircles oral margin. These bands (0.14 of width of window) meet along tops of windows and along their sides, leaving clear triangular areas at nodes below oral margin. Similar clear non-reticulate areas, often quadrilateral with concave sides, occur at nodes of trabeculæ on bowl. Bowl with six rows of unequal fenestræ, numbering 9–10, 12–13, 13–15, 12–15, 12–13, and 6–10, respectively, in the rows from nuchal region aborally, less regular in size and in arrangement than in *mitra*, except for first row, which is quite regular in both respects; successive rows below first being progressively less regular, with smaller fenestræ interpolated singly or in short series, or at nodes between larger ones. Fenestræ in first row 0.50–0.75 size of windows. Second row with unequal fenestræ ranging from the size in first row to much smaller, becoming still smaller in lower rows. Fenestræ rounded to narrow ellipsoidal or oval in shape. Trabeculæ heavy, devoid of reticulations. Rim around each fenestra like that around windows. All windows and fenestræ closed by delicate, clear panes. No coccoliths seen in wall. Animal quite large, filling 0.7 of cavity. Closing-apparatus conical (58°) with 4 blades on one side, with its lower end at base of collar and sharp apex appearing above oral margin.

Five loricæ: L., total, 40–48 (43.6); collar, 12–13 (12.8); bowl, 27–34 (30.8). D., oral, 30–33 (31.4); neck, 29–32 (30.2); bowl, 34–36 (35.6) μ.

"Die Dictyocysten sind sonst, im Gegensatz zu den meisten anderen Gattungen von Tintinnodeen, frei von Mündungszähnen," says Brandt (1907, p. 73) of *D. templum* var. *g* (=*D. extensa* K. and C.). We do not agree with him or with Jörgensen (1924, p. 86) that teeth are absent, or are due to an "optical delusion" [*sic*], since we find them clearly present on our loricæ, and Brandt's excellent figure of *extensa* (pl. 3, fig. 6) shows them distinctly.

At 10 stations, viz., at 1, 1, and 8, respectively, in Panamic Area, Galapagos Eddy, and Drift; at 68–81 (74.7)°; 14 loricæ.

Dictyocysta tiara Hæckel

Plate 26, fig. 9

Lorica elongate, with tall collar with a row of 6–8 rectangular windows; elongated subconical bowl; blunt aboral end; with postequa-

torial row of fenestræ, often supplemented by an anterior pre-equatorial row of smaller fields and sometimes by a second postequatorial one of large fenestræ; 1.49–1.78 (1.69) o.d. Oral margin strongly undulating, with 6–8 arches surmounted by a thin, continuous, hyaline list. Diameter of oral opening 0.56–0.67 (0.61) t.l., or 0.79–0.88 (0.84) diameter of bowl. Collar erect, subcylindrical, and with slight anterior to median lateral concavity, 0.31–0.36 (0.33) t.l., or 0.51–0.65 (0.57) o.d. in length; its least diameter (0.96 o.d.) at 0.27–0.50 its length from oral margin. Nuchal diameter equals oral. Bowl broadly ovoidal and subconical aborally, 0.64–0.69 (0.67) t.l., or 1.07 o.d. in length. Upper bowl a segment of a truncate, somewhat convex cone (72°), 0.09, or 0.16 o.d. in length. Equatorial diameter 1.13–1.26 (1.19) o.d., or 0.68–0.76 (0.73) t.l., at 0.46–0.50 t.l. below oral margin. Lower bowl contracted, inverted acorn-shaped, for half its length below equator fitting into contour of a hemisphere, then elongating and contracting into convex subconical contour, exceeding that of hemisphere by 1.14 its lateral radius, forming distally a convex cone of 120°. Aboral end contracting to a blunt but not emergent point. Wall of collar with a single row of 6–8, usually 7, tall subequal subrectangular windows, with rather broadly rounded corners. Vertical mullions and arched circumoral style subequal in section, both rather heavy and wider than in related species; flaring at either end to twice their median width; style thinning down in middle of each arch to somewhat less than mullions. Clusters of minute, rounded polygons filling triangular nodes, and a single line of them down each vertical mullion and in lower transverse mullions. Windows nearly twice as long as wide, closed by hyaline panes. Bowl fenestrate with fairly uniform secondary polygons, 20 across widest part of bowl, and 16–20 from end to end of bowl, subrectangular to hexagonal in shape, subuniform in size, and surrounded by a raised reticulum. Postequatorial zone of 8–10 rounded to subangular major fenestræ, 4–10 times as large as small secondary polygons of general reticulum, subequidistant and subequal, with major axis vertical or inclined 4° to right, three-quarters as wide as long. Major row supplemented by a pre-equatorial row of 20 minor fenestræ half the size of those of major row, with same shape, direction, and proportion. Posterior zone of 6–8 fenestræ, very similar to anterior row. Regularity of rows of larger areas often broken by invasion and crowding of smaller ones and by dispersal of intercalary fenestræ of various sizes and shapes into minor rows. Some loricæ with only a pre-equatorial row of fenestræ and remainder of bowl filled with small polygonal or rounded fields of varying sizes and ir-

regular arrangement passing into the primary prismatic meshwork of the surrounding raised reticulum. Loricæ at Sta. 4666 and adjacent stations with coccoliths of *Umbilicosphæra mirabilis* and *Syracosphæra pulchra* filling secondary mesh. In one lorica, *Coccolithophora leptopora* studded the anterior 0.2 of bowl, leaving remainder to other coccoliths. In loricæ without coccoliths fenestræ have subhexagonal network of trabeculæ about them. All fenestræ closed by hyaline panes. Wall made up of a single layer of rectangular, subequal prismatic polygons. Animal fills the greater portion of cavity.

Ten loricæ: L., total, 62–66 (64.3); collar, 20–24 (22.5). D., oral, 37–40 (39.3); bowl, 46–51 (47.0) μ.

This frequently figured species was originally founded by Hæckel (1873, pl. 27, fig. 1), presumably upon a deformed lorica (see Kofoid, 1915), so that the type figure probably does not adequately illustrate either its dimensions or proportions. Should normal loricæ of the type figured by Hæckel (1873) be discovered it will be necessary to retain Hæckel's name for them and to use Laackmann's (1909) name *indica* to designate the species for which we utilize Hæckel's older name.

At 9 stations, viz., at 1, 6, and 2, respectively, in California and Peruvian currents, and Drift; at 66–69 (67.5)°; 120 loricæ.

XIII. TINTINNIDÆ Claparède and Lachmann emended Claus emended Kofoid and Campbell

Tintinnoinea with loricæ of various forms, usually elongated, tubular, fusiform, amphora- or trumpet-shaped, usually rigid (flaccid only in Daturella); oral rim entire or toothed; suboral region often flaring; shaft or bowl cylindrical, subconical, or pyramidal; aboral end either open or closed; lacking prominent spiral structure in wall; never with rings; wall hyaline, bilaminate, mostly lacking secondary structure; often with longitudinal striæ, ribs, or fins, either vertical or with dextral or sinistral torsion; marine, with 1 species in brackish water, mostly eupelagic in warm seas, but with a few representatives in polar seas.

The most highly evolved and complex family of Tintinnoinea, judged by size and structural complexity of lorica, with three subfamilies, each with its own progressive series of genera. Of the three subfamilies, two, the Tintinninæ and Stelidiellinæ, are closed aborally like the great majority of other Tintinnoinea, and one, the Salpingellinæ, has aborally open loricæ; a feature seemingly developed independently in normal form only in Laackmanniella and Leprotintinnus. In a few

species of Tintinnopsis, such as *Tps. aperta, radix,* and *panamensis,* a posterolateral aboral opening resembling an artifact habitually occurs.

The loricæ of this family are hyaline and homogeneous for the greater part. Secondary structure, a prominent character of the thick-walled families such as the Codonellidæ and Ptychocylidæ, is wholly lacking, except in isolated instances such as in *Epicranella prismatica,* in which it appears to have been independently developed. This general hyalinity is similar to that of the Undellidæ, but the patterns of the lorica in that family are wholly different and lack longitudinal differentiation.

The loricæ of the Tintinnidæ are exceedingly varied in form. While the most primitive genera are simple and tubular, differentiation among the smaller genera results in fusiform or amphora-, tall goblet-, or slender beaker-shaped loricæ; however, the largest and most speciated genera are also tubular although trumpet-shaped when most specialized. Special modifications of form are highly developed in certain genera, as, for instance, in Odontophorella, Salpingacantha, Daturella, and among the fenestrated species of Stelidiella. Faceting is developed widely and is best seen in Rhabdosella and Epicranella in each of which it appears to have been evolved independently. Cytosome with 2, 4, or 8, macronuclei and 16–24 membranelles. Binary fission accomplished by development of new lateral cytostome on the posterior daughter which retains the parental lorica, and the anterior one secures the new lorica. Species of this family vary to an extraordinary degree in length, from 42μ to 650μ, the latter figure (for *Eutintinnus birictus*), being, except for *Leprotintinnus neriticus* at 1500μ and *Parafavella denticulata* at 750μ, the largest in the Tintinnoinea. Marine and principally eupelagic, only a single species, *Eutintinnus tubus,* from brackish water; the greatest speciation attained in tropical waters.

Contains 20 genera and 136 species, represented by 17 genera and 87 species in Expedition material. Tintinnus, Bursaopsis, and Proamphorella, Kofoid and Campbell gen. nov. mss. for systematic reasons, also mentioned. Of the 17 genera in Expedition material, 2, Prostelidiella and Eutintinnus, are new, and Rhabdosella, is raised from subgenus to genus. Includes 3 subfamilies; Tintinninæ, with 10 genera and 42 species, of which there are 7 genera and 23 species in Expedition material; the Stelidiellinæ, with 4 genera and 12 species, of which all are present; and the Salpingellinæ, with 6 genera and 72 species, of which all genera, and 53 species are present.

The affinities of the Tintinnidæ are not clearly defined. Longitudinal structures often with more or less torsion occur widely throughout

the family and also in the Rhabdonellidæ, a family which shows a slight tendency in the direction of a suboral flare, a feature widely prevalent among Tintinnidæ. The simplest genera of the Tintinnidæ, such as Tintinnus (as here restricted) and Canthariella, have a general resemblance in form and proportions to some species of Tintinnidium and Tintinnopsis, the most primitive genera of Tintinnoinea. This resemblance seems to have more significance than that of the specialized longitudinal striæ and to suggest that this large and highly differentiated family must have had its evolutionary origin far back in the history of the group. However, spiral structure evident in so many of the lower families, is superseded in this highly evolved family by vertical modifications of the lorica.

Certain changes are required in the subfamily names from those earlier given by us (1929). The subfamily Tintinninæ was called Amphorellineæ by us in 1929, and the Salpingellinæ was called Tintinnineæ. This change has been brought about by the restriction of Tintinnus to species with closed aboral end, and by the introduction of Eutintinnus for species with an open aboral end. Tintinnus *sensu stricto* becomes the type genus of the Tintinninæ, the primitive family with closed aboral end. The withdrawal of Tintinnus *sensu stricto* from its associates in our original Tintinninæ leaves the remainder without a type genus. For this we select Salpingella and establish a new subfamily, the Salpingellinæ. One subfamily, the Stelidiellinæ, remains unchanged.

Subfamily TINTINNINÆ nom. subfam. nov.

Amphorellineæ K. and C., 1929, p. 303.

Tintinnidæ with lorica rather small and short; collar, if present, funnel-shaped; without a nuchal groove or a suboral ledge; aboral end closed, with or without a pedicel or horn; longitudinal structures, except in Amphorella and Amphorellopsis rather feebly, if at all, developed; all marine.

Simplest and most primitive subfamily, with its primitive features in slight differentiation of suboral and aboral regions. Thus, in Tintinnus (*sensu stricto*) and Bursaopsis there is no differentiation of the collar. In all the other genera of this subfamily it is at the most merely a funnel-shaped flare without rim, thickening, ledge, shelf, or trough of any sort. Only in *Dadayiella bulbosa* and *Odontophorella serrulata* are denticles or circumoral spinules present. The aboral region is rather more differentiated, but only in a relatively few species. It is

hemispheroidal or flattened in Tintinnus, Bursaopsis, and some species of Canthariella and Steenstrupiella; truncated in Proamphorella; angled in some species of Canthariella and Steenstrupiella; pointed in Amphorellopsis, Odontophorella, Albatrossiella, and Dadayiella; and provided with an aboral horn in Albatrossiella and Dadayiella. The extreme differentiation of the aboral region in the whole family Tintinnidæ is attained in *Dadayiella jörgensoni* in which the aboral horn has a terminal radiating ring of horizontally projecting spikes. The longest aboral horn, relatively to the total length, in all of the Tintinnoinea is developed in *Albatrossiella filigera*.

The linear, usually longitudinal, structures which are characteristic of so many genera of the Tintinnidæ, are variously and, in some genera in the Tintinninæ, rather highly developed. They are wholly lacking in Tintinnus, Albatrossiella, and some species of Canthariella. They are present as full-length, but interrupted vertical striæ in Bursaopsis; as short, incipient, aboral striæ in some species of Canthariella and Steenstrupiella; as suboral vertical striæ in Dadayiella (full-length in *D. cuspis);* as spiral full-length fins in Proamphorella; vertical full-length fins in Amphorella and Odontophorella; and partial or full-length ones in Amphorellopsis. In Odontophorella the added feature of serrations on the fins appears, the only instance of longitudinal serration in the Tintinnoinea.

In this subfamily the main lines of evolution have been development of aboral horn and of longitudinal fins. Neither torsion of linear structures nor differentiation of the suboral region into subsidiary specialized structures have developed in the Tintinninæ to an extent comparable to that attained elsewhere in the Tintinnoinea.

The Tintinninæ contain 10 genera, as follows: — Tintinnus (5 species), Bursaopsis (12), Canthariella (4), Steenstrupiella (5), Proamphorella gen. nov. (1), Amphorella (6), Amphorellopsis (7), Odontophorella (1), Albatrossiella (3), and Dadayiella (8). Proamphorella gen. nov. Kofoid and Campbell mss. is founded on *Bursaopsis quinquealata* (Laackmann) K. and C. (1929, p. 305), originally described as Tintinnus, its type and only species.

Subfamily STELIDIELLINÆ Kofoid and Campbell (1929)

Tintinnidæ with fairly short and stout lorica; collar highly developed either as a wide, projecting, low dish, shaped like a deep soup plate, or with a circumoral ring and a ledge, or nuchal cone, below it; bowl scabbard- or sack-shaped, or inverted conical; aboral end always

closed; full-length or partial longitudinal structures usually present (not in some species of Ormosella); wall lacking evident prismatic structure; marine in tropical and subtropical seas.

The most highly specialized subfamily of the three in the Tintinnidæ, in structural development of the suboral region, taking the form in Ormosella of a wide, overhanging collar comparable to that in simpler species of Codonella and Cyttarocylis, but more squarely set off below, without parallel in any other genus in the Tintinnidæ. In Prostelidiella and Stelidiella this suboral funnel is divided into two regions, a relatively narrow, erect, or flaring circumoral ring, and an inverted truncated conical nuchal cone below it, which in Stelidiella is fenestrated. Fenestræ do not occur elsewhere in the Tintinnidæ, and in the Tintinnoinea only in the Dictyocystidæ and in *Xystonellopsis ornata*. In Brandtiella the suboral region is divided into the flaring circumoral ring and an angular suboral ledge below it.

Aboral end of the Stelidiellinæ very diversely differentiated; bluntly oracutelypointed; drawn out in an elongated aboral horn in Ormosella; bluntly rounded in Brandtiella; angled in Canthariella and in Prostelidiella and Stelidiella due to structural influence of longitudinal angles on bowl. These angles also influence the shape of this region in Brandtiella.

Longitudinal structures on bowl are present in all of genera, though not noted in three species of Ormosella, but in the other four ranging in number from 7 to 12 and extending from nuchal region to aboral horn; in Prostelidiella and Stelidiella forming prominent projecting angles extending from nuchal region to aboral end and giving an angular faceting to whole bowl; and in Brandtiella few, and confined to lower end of bowl.

In the evolution of this subfamily the suboral region reaches the maximum differentiation in the Tintinnidæ, the aboral region, however, except in Ormosella, remains in the primitive angled (Canthariella) condition, and the longitudinal structures remain rather simple and do not develop torsion.

Contains 4 genera, as follows: — Ormosella (7 species), Brandtiella (1), Prostelidiella gen. nov. (1), and Stelidiella (3).

Subfamily SALPINGELLINÆ nom. subfam. nov.

Tintinnineæ K. and C., 1929, p. 327.

Tintinnidæ with elongated, tubular, or trumpet-shaped loricæ; oral margin either unmodified, entire, toothed, flaring, everted, or reflexed,

with or without a circumoral brim; suboral funnel usually but not always present, never fenestrated; bowl cylindrical, or narrowly inverted subconical, with or without a median bulge, and often with a more contracted inverted aboral cone; aboral end always open, broadly in Eutintinnus, narrowly with a short conical or cylindrical terminal aboral region in Salpingella and Epicranella; longitudinal structures either lacking, confined to aboral or to suboral and aboral regions, or full length, often with torsion, sometimes elevated as fins, or arched below the circumoral brim; wall lacking evident prismatic structure except in Daturella and locally in some species of Epicranella; marine, in all seas, but largely tropical.

The evolution of the Salpingellinæ has taken three major lines: The first is exhibited in the elongation and increase in diameter of the more or less tubular or inverted subconical bowl, which attains its maximum in *Eutintinnus birictus* and *Salpingella regulata;* the second, in the gradual expansion, and even eversion, of the truncated aboral end; and the third line, in differentiation of circumoral and suboral regions.

The shaft or bowl in simpler species of Eutintinnus, such as *pacificus*, *tubus*, and *apertus*, is short, as in the primitive genus Tintinnus (*sensu stricto*), and its open aboral end is only somewhat enlarged. In Daturella, also, the simplest species, *D. angusta*, has a relatively short lorica. In Salpingella and Salpingacantha the simplest species are also the shortest, as, for example, *Salpingella lineata* and *Salpingacantha crenulata*. Within the genera Eutintinnus, Daturella, Salpingella, and Salpingacantha, there has been a progressive evolution among their species in size, especially in length, often accompanied by structural evolution in suboral and aboral regions or in longitudinal structures. The ranges in size within these genera are among the greatest in the genera of the Tintinnoinea.

The suboral region has undergone a considerable variety of more or less correlated differentiation. In Eutintinnus and Rhabdosella the differentiation is limited to a short, slight suboral flare, and at the most to only a slight thickening of oral rim, except in the subgenus Odontotintinnus, in which there is little or no flare and the oral margin is minutely toothed. This denticulation occurs elsewhere in the Tintinnidæ in Odontophorella, *Dadayiella bulbosa*, *Stelidiella stelidium*, *Daturella emarginata*, and, perhaps by artifact, in Salpingacantha. It is thus a rather frequently emergent character in this family and may be correlated with the prevalence of other longitudinal differentiations therein. It thus appears in this subfamily even in Eutintinnus, in

which other vertical structures are wholly absent. In Daturella, Salpingella, and Salpingacantha the suboral funnel widens to a trumpet-shaped form and the oral rim develops a slight marginal thickening, widens to a horizontal brim, and even becomes reflexed, as it is in all species of Epicranella. In the graceful loricæ of Epicranella the under surface of the brim and the outer surface of the suboral cone are adorned with a necklace formed of spiraled ribs and suboral arches.

Aboral region squarely truncated in all genera, the subfamily falling into two distinct groups with regard to its shape; in Eutintinnus and Daturella more or less widely open, even almost as widely as the oral end, as in *E. mirabilis* and *tubiformis*. A general survey of the Tintinnidæ as a whole suggests that this condition is not the primitive one but has evolved from the closed type seen in Tintinnus. In this event the subgenus Ceratotintinnus, with a contracted aboral region and narrow opening, is more primitive than the subgenus Eutintinnus, with the wide opening; and the genera, such as Salpingella, with contracted aboral ends, are more primitive than Eutintinnus and Daturella with more widely open ends. The second group in the subfamily consists of Salpingella, Salpingacantha, Rhabdosella, and Epicranella, in which the aboral end is contracted and the opening very small. There is a marked tendency for a very short aboral cylinder to be formed at the aboral tip in all of these genera. An open aboral end occurs elsewhere in the Tintinnoinea in *Tintinnidium primitivum* Busch, which Hofker (1931b) has shown quite correctly to be only the incomplete lorica of *Tdm. incertum* with a closed aboral end when completed. It also occurs in full extent in Leprotintinnus, Laackmanniella; in Climacocylis in quite irregular form, as though induced by some accident, as also in *Tintinnopsis aperta, panamensis,* and *radix;* in like fashion at times in *Codonellopsis longa;* and occasionally in species of Cyttarocylis and Xystonellopsis as a minute canal. This wide distribution is suggestive of the relationship of this opening to the varying persistence and effect on the structure of the aboral end of the protoplasmic connection of the daughter schizonts during and at the close of the formation of the lorica at fission.

Longitudinal structural differentiations in the Salpingellinæ present a wide range in evolution. In the aberrant Daturella they range in number from 4 to 14, and in length from 0.75 total length to full length, and in direction from vertical to right and left torsion, except in the questionable species *D. angusta* (Bdt.), in which no striæ appear. They are full-length in *Rhabdosella octogenata,* whereas they are in a suboral and an aboral group of different number in *cuneolata.* In

Salpingella and Salpingacantha they are developed as low fins and vary in length from a short aboral zone to full length, are rarely separated, as in *Salpingella jugosa*, into a suboral and an aboral group, and generally have but little torsion except in *Salpingella altiplicata*. In Epicranella they are full length only in *E. prismatica*, being in the two groups in other species and always having considerable torsion, both right and left occurring in this genus. Faceting of the intercostal spaces occurs in Rhabdonella and Epicranella.

Contains 6 genera, as follows: Eutintinnus gen. nov. (30 species), Daturella (8), Salpingella (25), Salpingacantha (7), Rhabdosella (2), raised from subgeneric to generic status in this Report, and Epicranella (5).

34. TINTINNUS Schrank emended

Tintinnus, Apstein, 1915, p. 123.
Tintinnidium, K. and C., *partim*, 1929, p. 9 (see also Tintinnidium).
Tintinnus, K. and C., *partim*, 1929, p. 329 (see also Eutintinnus).

Tintinninæ with lorica without flaring collar; oral margin entire; aboral end closed and rounded; wall hyaline without evident structure. The known species are all from marine or brackish waters. Type species *Tintinnus inquilinus* (O. F. Müller) Schrank from the Baltic off Copenhagen, as designated by Apstein (1915). Tintinnus as here restricted differs from all other genera in the Tintinninæ except Bursaopsis in the broadly rounded aboral end, and from Bursaopsis in the absence of longitudinal striæ or other structural modifications of the wall.

Includes only 4 species, as follows:—*bursa* (Cleve) Brandt, *inquilinus* (O. F. Müller) Schrank, *obliquus* Claparède and Lachmann, and *vitreus* Brandt.

In our *Conspectus* (1929) we went to considerable pains to clear up the confusion over *Tintinnus inquilinus* and *Tintinnidium fluviatile* and endeavored to meet the nomenclatural difficulties by recognizing both and assigning both to the genus Tintinnidium. Unfortunately, we overlooked Apstein's (1915, p. 123) designation of the species *inquilinus* as the type of the genus Tintinnus. This genus as generally conceived, and as treated by us (1929), had been limited to species with loricæ in which the aboral end is widely open. The wealth and variety of species which have been accumulated in the course of more than a century since O. F. Müller (1776) first described *Trichoda inquilina*, and especially the diversity of forms brought to light by the

Expedition to the Eastern Tropical Pacific, compel a segregation of the diversified types assigned, even by Jörgensen (1924), to Tintinnus into a number of different genera which can be clearly defined by their morphology. As Jörgensen's paper clearly shows, it was even then wholly impossible to give a generic diagnosis to Tintinnus *sensu lato*.

Apstein's unfortunate choice of the species *inquilinus* as the type of Tintinnus makes it necessary to restrict this name to a small group of species with rounded, aboral ends, and to part the name Tintinnus from the largest group of species in the whole family Tintinnidæ with which it had so long been associated, namely, the tubular species with open aboral ends, now designated in this Report as the genus Eutintinnus. We accordingly retract our assignment of this species *inquilinum* from Tintinnidium, where we had associated it with other species with rounded aboral ends, but all of which, except *inquilinum*, had a "mucilaginous" basis for the lorica and were covered with adherent particles. The species *inquilinum* alone in Tintinnidium as then revised by us had a finer, hyaline texture. Additional reasons for our placing it in Tintinnidium were its size and proportions and the fact that some species, such as *Tdm. semiciliatum* and *Tdm. fluviatile*, had but few or small adherent particles.

We now return the species *inquilinus* to the genus Tintinnus as its designated type (Apstein, 1915) and retain in Tintinnus only this type, and *T. bursa* (Cleve) Brandt, *T. obliquus* Claparède and Lachmann, and *T. vitreus* Brandt. *Tintinnus ramosus* Lohmann (1920, pp. 228, 467) is a *nomen nudum*, the allocation of which cannot be made for lack of data.

35. BURSAOPSIS Kofoid and Campbell emended

Bursaopsis, *partim*, K. and C., 1929, pp. 303–305, figs. 576–581 (see also Dadayiella, Tintinnus, and Proamphorella).

This genus was established by us (1929) as a convenient receptacle for a group of 7 species not readily allocated in other genera. They had all been described in either Tintinnus or Amphorella, but were excluded from the former as restricted by Jörgensen (1924) and accepted by us (1929), to tubular loricæ with open aboral ends, by their closed aboral ends, and from the latter by the absence of a flaring collar and (except in *B. quinquealata* [Laackmann] K. and C.) the absence of fins. Our assemblage of species in Bursaopsis was somewhat incongruous, since it included the finned *B. quinquealata*, the striate *B. puncto-*

striata and *B. striata*, the non-striate *B. vitrea*, *B. bursa*, and *B. obliqua*, and the "tubular subulate" *B. fergusoni*.

In our *Conspectus* (1929) we followed Jörgensen (1924) in restricting the genus Tintinnus to species with tubular loricæ with open aboral ends. In so doing, we, in common with Jörgensen, overlooked Apstein's (1915) earlier designation of *Tintinnus inquilinus* O. F. Müller (1776, as *Trichoda inquilina*) *with a closed aboral end*, as the type species of the genus Tintinnus. We had also followed Fauré-Fremiet (1908a) in shifting *Tintinnus inquilinus* to Tintinnidium, in the opinion that this species with a closed aboral end did not belong to Tintinnus.

To meet the nomenclatural situation created by Apstein's designation of *Tintinnus inquilinus* as the type species of Tintinnus, we are in this monograph excluding from Tintinnus, as thus typed, all species with open aboral ends, and designate the genus for species with open aboral ends as Eutintinnus, with *E. birictus* as the type. The characters of the genus Tintinnus *sensu stricto* thus become a hyaline lorica, closed, rounded aboral end, and absence of fins, striæ, and specialized collar. As thus defined, it becomes feasible to transfer from Bursaopsis to Tintinnus a group of three species, *B. vitrea* (Brandt) K. and C., *B. bursa* (Cleve) K. and C., and *B. obliqua* (Claparède and Lachmann) K. and C. The aberrant *Bursaopsis quinquealata* (Laackmann), with Amphorella-like fins, is removed to a new genus, Proamphorella. The disposition of *B. fergusoni* (Ryder) K. and C. presents difficulties in the absence of figures. The description determines the fact that the lorica is hyaline, the aboral end closed, and the oral margin strongly toothed or serrate. The lorica is also stated to be subulate. The genus which may most readily receive such a species is Dadayiella, which has species with hyaline subulate loricæ with closed aboral ends. There are no toothed species in the genus except as unfinished (?) loricæ of *D. ganymedes* (see K. and C., 1929, fig. 670) sometimes have the suboral striæ extending beyond the oral margin as slender, acicular teeth. This leaves in Bursaopsis only two species, *B. striata* (Daday) K. and C., the type, and *B. punctostriata* (Daday) K. and C. To meet the species content of Bursaopsis thus reduced, the generic characters are here emended as follows:

BURSAOPSIS Kofoid and Campbell emended

Lorica hyaline, more or less elongated; oral margin entire; no flaring collar; aboral end closed, rounded, without point or horn; wall striate with longitudinal striæ, but without fins.

Type species *Bursaopsis striata* (Daday) K. and C. from Mediterranean off Naples. Includes also *B. punctostriata* (Daday) K. and C.

36. CANTHARIELLA Kofoid and Campbell

Tintinninæ with lorica small, capsular, 1.72–2.20 o.d.; collar conical (45–60°), with definite nuchal angle; oral margin entire; bowl subcylindrical subconical; aboral end truncated, angular, or acute, with or without faint posterior facets; no longitudinal fins, but faint angles in *C. septinaria;* marine, in tropical seas. Type species *Canthariella brevis* K. and C. from Sta. 4722 in Drift of Pacific.

Contains 4 species of which 3, *brevis, septinaria,* and *truncata,* all new, occur in Expedition material. C. *pyramidata* occurs in the Mediterranean.

Canthariella brevis Kofoid and Campbell

Plate 28, fig. 12

Lorica inverted campanulate anteriorly, inverted subconical below, tapering in aboral 0.7 t.l., contracting abruptly to angular aboral end; 2.0–2.2 (2.1) o.d. Collar segment of slightly convex, inverted, truncated cone (50°), 0.2 t.l. Nuchal diameter 0.75 o.d. Bowl subconical, 0.8 t.l., tapering uniformly in a slightly convex inverted segment of a cone of 7°. Aboral region 0.3 o.d. in length, an inverted cone of 52–55°, terminating in an acute antapex. No facets. Wall thickened in nuchal region. Animal with 2 spherical macronuclei, 10μ in diameter.

Three loricæ: L., total, 47–54 (50.0). D., oral, 23–24 (23.3); midway, 15μ.

At 3 stations, in Drift; at 75–81 (77.0)°; 3 loricæ.

Canthariella septinaria Kofoid and Campbell

Plate 28, fig. 16

Lorica inverted campanulate anteriorly, subconical below, with abruptly blunt aboral end; 1.72–1.79 (1.75) o.d. Collar like end of trumpet, a segment of an inverted convex cone of 60°, 0.18–0.21 (0.19) t.l. Nuchal diameter 0.73–0.79 o.d. Bowl inverted subconical 4° anteriorly, and abruptly 25° distally, increasingly convex posteriorly, 0.8 t.l., with greatest diameter (0.8 o.d.) at throat. Aboral region for

0.25 t.l. faintly marked by 7–8 equidistant regular angles, with 7–8 flattened facets between, fading out anteriorly and merging posteriorly in broadly rounded, subtruncate aboral end; with faint aboral angulation formed by termination of facets, and diameter at level of contraction 0.5 o.d. Wall with greenish tinge, very thin at oral margin, thickening in nuchal region, thinning gradually in aboral region. Surface in lower 0.5–0.8 t.l. not uniformly convex outwardly, but flattened, with 7 or 8 longitudinal, plane, or slightly concave facets, with recurrent thickening of wall as focus passes the angles. Attached naviculoid diatoms of small size of the genus Cocconeis were found on one lorica arranged in a circle around aboral end, with long axes vertical, as in diatoms on *Salpingella acuminata*. Animal with 2 ellipsoidal macronuclei 3.5 by 5μ, with adjacent spherical micronuclei 2μ in diameter.

Three loricæ: L., total, 50–52 (51.0); collar, 9–11 (10.0); bowl, 41. D., oral, 29; nuchal, 22–24 (23.3)μ.

At 4 stations, in Drift; at 70–75 (73.2)°; 4 loricæ.

Canthariella truncata Kofoid and Campbell

Plate 28, fig. 11

Lorica small, with slender subcylindrical bowl and a truncated aboral end; 1.75–1.92 (1.79) o.d. Collar a segment of an inverted truncate cone of 45–50°, with straight outer surface 0.19–0.26 t.l. in length. Nuchal diameter 0.6 o.d. Bowl subcylindrical, with greatest diameter midway, a trifle greater than nuchal; 0.8 t.l.; lower half a segment of a slightly convex inverted cone of 8°. Aboral end squarely truncated, with rounded angles, 0.3 o.d. in diameter. Wall uniformly very thin, very hyaline, homogeneous throughout.

Two loricæ: L., total, 42–57 (49.2); collar, 8–13 (11.2); bowl, 34–44 (38.2). D., oral, 24–30 (27.2); midway, 16–23 (18.2); aboral end, 8–9.

At 2 stations, in Drift; at 72–75°; 2 loricæ.

37. STEENSTRUPIELLA Kofoid and Campbell

Tintinninæ with lorica from peg- to stout nail-shaped; 2.10–6.28 o.d. in length; oral margin always entire; oral aperture 0.2–0.6 t.l. in diameter; collar steep or low funnel-shaped, concave or convex outwardly, a segment of an inverted cone of 32–40°; bowl stout or elongated, 0.80–0.94 t.l., cylindrical to subconical anteriorly, sometimes

with median inflation or contraction, posteriorly slightly tapering, or slightly inflated; aboral region sack-like; aboral end rounded, pointed, or pyramidal (40–75°), with 4–10 vertical decurrent striæ or low fins, 0.11–0.30 t.l.; marine. Type species *Steenstrupiella steenstrupii* (Claparède and Lachmann) K. and C. from North Sea off Norway.

A unique genus somewhat like Canthariella in form but differing in more widely flaring, more nearly horizontal collar, instead of higher, funnel-shaped collar of latter. The bowl usually has a posterior inflation above antapex, quite unlike tapering bowl of Canthariella, but different in form from posteriorly inflated bowls in other Tintinninæ, such as the pedicellate genera Dadayiella and Albatrossiella or the pointed Amphorellopsis and Odontophorella; resembling superficially Salpingella, but differing from it in less flaring collar, posterior inflation, and closed aboral end. Differs from Amphorella in absence of truncate antapex, less bulge of bowl, more abrupt flare of collar, and more slender lorica. Collar resembles that of Albatrossiella and some species of Amphorellopsis. The feeble development of striæ and their limitation to a posterior location is forecast in the feeble posterior striæ of *Canthariella septinaria.* In shape of collar and posterior striæ, Steenstrupiella leads in direction of Salpingella.

Established by us (1929) for species included previously in Amphorella, Stichotricha, or Tintinnus. *Tintinnus steenstrupii* was first described by Claparède and Lachmann (1858), and later by Daday (1887b), who placed it in Amphorella. Together with *Stichotricha inquilinus* (Entz, Sr., 1884) (=*Steenstrupiella entzi* K. and C.) it has been allocated to either Tintinnus or Amphorella by previous writers. Jörgensen (1924) added *Amphorella intumescens* (Jörgensen) and *gracilis* (Jörgensen) from the Mediterranean, noting their relationship to the above species. We (1929) recognized all four, adding *robusta* K. and C. to them, and separated this homogeneous group of elongated species from Amphorella on basis of rounded instead of truncate aboral end, and striæ instead of highly developed fins on aboral region of bowl.

Includes 5 species, of which 3 are present in Expedition material. Of the 5, *robusta* was new, and *entzi* was given as a new name by us (1929).

Steenstrupiella gracilis (Jörgensen) Kofoid and Campbell

Plate 28, fig. 2

Lorica minute, stout phial-shaped; 2.10–2.56 (2.31) o.d. Collar a low, truncated funnel forming a segment of a convex inverted trun-

cated cone of 62°, 0.13 t.l. Nuchal diameter 0.50–0.65 o.d. Bowl sack-like, 0.87 t.l., cylindrical in anterior 0.55–0.66, with diameter decreasing slightly near middle; slightly inflated below middle to 0.65 o.d. at 0.77 t.l. from oral margin. Aboral region an inverted pyramid of 60° below inflated region, hexagonal in cross section, and pointed or bluntly truncated aborally, according to the side viewed, with 4 or 6 longitudinal, subequal, subequidistant angles or rounded elevations, 0.12 t.l. in length, running towards aboral end, marking boundaries of flattened sides of posterior pyramid, but not forming fins, continuing to aboral end, as in Stelidiella, but less clearly marked. Wall hyaline, homogeneous, with slightly greenish tinge. Wall of collar at nuchal level; thinning out to oral margin. Wall of bowl thicker midway and thinner posteriorly. Animal with 2 large oval macronuclei, 8 by 10 μ.

Seven loricæ: L., total, 61–76 (70.9), D., oral, 28–32 (30.4); midway, 15–18 (16.5) μ.

The "2 striæ" figured by Jörgensen (1924, fig. 19) are probably due to the greater development of 2 of the 6 angles and may be associated with the truncate aboral end figured by him.

At 17 stations, viz., at 2, 1, 1, 2, and 11, respectively, in California Current, Easter Island and Galapagos eddies, Panamic Area, and Drift; at 68–83 (73.5)°; 22 loricæ.

Steenstrupiella robusta Kofoid and Campbell

Plate 28, fig. 14

Amphorella steenstrupi, Alzamora, 1929, p. 6, fig. 12.

Lorica elongated, medium sized phial-shaped; 3.3–4.3 (3.7) o.d. Collar a low, truncated funnel of 80°, with slightly convex sides rounding up at rim, 0.1 t.l. Nuchal diameter 0.6 o.d. Bowl 0.9 t.l., elongated tubular in anterior 0.6 t.l., bulging hexagonal for 0.25, and a pyramid aborally. Anterior tubular portion circular in cross section, with greatest diameter (0.6 o.d.) at throat, decreasing very little but evenly posteriorly in a segment of an inverted cone of 6°, to somewhat below middle, to 0.5 o.d., then increasing below this level of greatest contraction to 0.55 o.d. at 0.18 its length from antapex, within a cone of 6–10°. Aboral end of bowl a blunt, low, inverted pyramid of hexagonal cross section, 0.07 t.l., with an included angle of 75–80°. Aboral end in some views truncated, because of relations of ridges to angle of vision. Ridges 6, equidistant, convex, longitudinal, 0.3 t.l., widest

midway. Wall with slight greenish tinge. Collar thickened with an Amphorella-like thickening just above throat, thinning regularly to oral rim; elsewhere very thin. Animal with 2 macronuclei. Posterior end subject to deformations in contour, due to its delicate structure.

Nine loricæ: L., total, 107–133 (120.9). D., oral, 29–37 (33.0); midway, 13–18 (15.0); posterior expansion, 14–20 (17.4) μ.

At 15 stations, viz., at 1, 2, 3, and 9, respectively, in California and Mexican currents, Panamic Area, and Drift; at 69–84 (77.3)°; 19 loricæ.

Steenstrupiella steenstrupii (Claparède and Lachmann) Kofoid and Campbell

Plate 28, fig. 5

Lorica elongated, stout nail-shaped, relatively slender, with a wide' flaring, low, bowl-shaped collar; 3.12–6.28 (4.70) o.d. Collar a widely flaring, low, bowl-shaped funnel forming a segment of a slightly convex inverted cone of 55–65°, 0.06 t.l. Nuchal diameter 0.6 o.d. Bowl elongated subcylindrical, narrow, 3–6 o.d. in length and 0.94 t.l., anteriorly evenly subconical (3°), narrowest (0.3 o.d. or 0.5 nuchal diameter) at or below middle. Tubular anterior bowl 0.8 t.l. Lower bowl slightly swollen, with greatest diameter (0.5 o.d.) at 0.33 o.d. above aboral end. Aboral end below this widest level a low, very convex inverted cone increasing aborally from 30° to 90° as a whole. Antapex bluntly rounded. Fins 6, vertical, subequidistant, low, extending from slightly above antapex anteriorly for 0.11 t.l.; in some loricæ very faint and apparently very soft and thin, as shown by injuries in many loricæ. Wall hyaline, with very fine prisms (Brandt, pl. 69, fig. 9); thicker above throat, thinning above and below. Wall of bowl thinning aborally. Animal with 2 ovoidal macronuclei, each 5 by 8 μ, located one above the other in opposite ends of long cytosome, and 18 membranelles.

Ten loricæ: L., total, 173–258 (208.0). D., oral, 36–43 (38.6); midway, 12–16 (14.3); aboral, 14–20 (17.8) μ.

Our loricæ are longer (173–258 μ) than those from the Atlantic (100–200 μ). In view of the similarity of our material in proportions to the original figure by Claparède and Lachmann, we allocate long slender loricæ to *steenstrupii* and stouter ones with less flaring collars and less constriction of bowl to *robusta*.

At 47 stations, viz., at 5, 4, 2, 2, 1, 10, 2, and 21, respectively, in

California, Mexican, Peruvian, South Equatorial, and North Equatorial currents, Panamic Area, Easter Island Eddy, and Drift; at 68–84 (75)°; 124 loricæ.

38. AMPHORELLA Daday emended Jörgensen, emended Kofoid and Campbell

Tintinninæ with lorica vase-like, 1.60–3.98 o.d. in length; oral margin always entire, circular or rectangular; collar funnel-shaped; bowl cylindrical, becoming convex, pyramidal aborally between fins and sometimes inflated; antapex closed, truncated; bowl with 3, 4, or 8 longitudinal ridges, angles, or fins, 0.5–1.0 t.l.; wall hyaline, without evident alveolar structure; animal attached laterally. Type species *Amphorella quadrilineata* (Claparède and Lachmann) Daday from off the coast of Norway. Varies in length from 66μ in *laackmanni* to a maximum of 220μ in *amphora;* oral diameters generally 40–50μ, 20μ in *laackmanni.* Statements (see Jörgensen, 1924, p. 16) citing Claparède and Lachmann's record (1858, p. 199) of a length of 300μ for *amphora* have persisted in the literature, though no investigator has since found a lorica of Amphorella of any such size. Furthermore, it is probable that Claparède and Lachmann's stated length of 200–300μ is in round numbers. When their figure of *Tintinnus amphora* (their pl. 8, fig. 3) is measured according to their stated magnifications (their p. 477 "de grossissement est de 300 à 350 diamètres"), its length is only 189–220μ.

Founded by Daday (1887b) on species which in the main had been previously included in Tintinnus. The generic characters which he utilized were transparent structureless wall, closed aboral end, and lateral attachment of animal to lorica. Jörgensen later (1924) noted several types of surface differentiation in Amphorella, but did not specify any one as distinctive, particularly not longitudinal fins, which we (1929, p. 307) later utilized as a generic character of Amphorella *sensu stricto.* Closed aboral end and fins are distinguishing characteristics which alone separate Amphorella from Tintinnus (=Eutintinnus of this monograph). Daday included 12 species, of which 2, *amphora* and *quadrilineata,* were retained by us (1929) in Amphorella in our revision; 2, *inquilinus* and *steenstrupii,* were included in Steenstrupiella; 3, *obliqua, punctostriata* and *striata,* in Bursaopsis; 1, *ganymedes,* in Dadayiella; 1, *subulata,* in Helicostomella; 1, *tuberculata,* in Codonellopsis; 1, *norvegica,* in Acanthostomella; and 1, *mediterranea,* in Metacylis.

The fins of Amphorella are very delicate and easily overlooked, a condition responsible for not a little systematic confusion. This confusion began with the investigation of Claparède and Lachmann (1858), who described two species as *Tintinnus amphora* and *T. quadrilineata*, the former without, and the latter with fins. Jörgensen (1924) reviewed the evidence from the widely investigated Norwegian plankton and concluded that no species corresponding to *T. amphora* had ever been found, basing his statement on the absence of fins in, and the large size of, *T. amphora*. He therefore reduced *amphora* to a synonym of *quadrilineata*, regardless of the fact that *amphora* has page and plate priority over *quadrilineata*. In the absence of rediscovery this decision is a matter of opinion. The size distinction fades out of the picture when one measures Claparède and Lachmann's figure. Their figured lorica of *amphora* actually measures only 189–220μ in length, a size comparable with that of some other species and at least partially within the known range in size (120–200μ) of *quadrilineata*. The seeming absence of fins, on the other hand, if actual, would exclude *amphora* from Amphorella as defined by us, and leave it in Tintinnus (*sensu stricto*), as limited in this Report. However, its shape, proportions, form of collar, and truncate aboral end clearly indicate that in these particulars its affiliation is with Amphorella. We therefore leave it in Amphorella, as did Brandt (1906, 1907), assume that Claparède and Lachmann (1858) overlooked the fins, and conclude that Brandt's *T. amphora* ("typisch") from the Gulf Stream, North Equatorial Current, and Irminger Sea, and also from off New Pomerania in the Western Pacific, is the species Claparède and Lachmann figured, but omitted the fins which Brandt later (pl. 69, fig. 6) found. Jörgensen (1924) gave to this figure of Brandt's the name *Amphorella quadrilineata* var. *brandti* on the assumption that it was not *A. quadrilineata*, and we (1929) raised it to specific status. As Jörgensen (1924, p. 18) points out, Brandt's figure, as compared with Claparède and Lachmann's, has a more flaring collar, but this character is quite variable in *quadrilineata* and changes with the pressure of the coverglass, while the nuchal thickening varies with the face presented to view. His three additional reasons for separating Brandt's figure from *A. amphora* are invalid. These are (1) the thicker wall in the collar region, (2) the posterior location of the aboral expansion of the bowl, and (3) the smaller size of Brandt's lorica. In the first place, Claparède and Lachmann do not figure the thickness of the wall. Their vague shading in the nuchal region, as elsewhere, is clearly for contour only. Therefore, a comparison of the two is not possible. Secondly, the region of great-

est expansion of the bowl is in its aboral half and is below the middle in both Claparède and Lachmann's and in Brandt's figures. The differences in the precise location of the greatest diameter are, at best, but slight, this diameter being located at 2.50 o.d. below the oral rim in Claparède and Lachmann's figure, and at 2.25 in Brandt's. Thirdly, the actual measurement of Claparède and Lachmann's figure based on its stated magnification (300–350 diameters) brings it within the range of Brandt's later measurements of his typical *T. amphora.*

An additional reason for concluding that Brandt's, rather than Jörgensen's, solution is the correct one, is that Brandt records *amphora* in currents tributary to Norwegian waters. In Brandt's records it is mainly tropical in occurrence, but probably drifts occasionally with Gulf Stream water into Norwegian coastal waters, where Claparède and Lachmann (1858) first found it. This conclusion fits the known facts of morphology and distribution into the systematic problem, leaves the old names undisturbed, and affords a workable basis for the recognition of the largest species of the genus.

Jörgensen (1899) corrected the errors into which Claparède and Lachmann (1858) fell regarding their *Tintinnus quadrilineatus,* first, that the so-called "cannelures" were in reality not furrows but external fins, and that there were three instead of four of these in *Amphorella quadrilineata* from Norway. In this paper and in later (1905) one, he concluded that *amphora* and *quadrilineata* were identical, and that Daday's (1887b, pl. 18, fig. 5) Naples specimen was a different species, which he named *A. dadayi* but whose validity he later (1924) abandoned.

Brandt's (1907) extensive material from the Atlantic explored by the Plankton Expedition brought him in contact with the puzzling conditions in the identification of species raised by the imperfections and contradictions in the previous work of Claparède and Lachmann (1858) Entz, Sr. (1884), Daday (1887b), and Bütschli (1889), and the added perplexities raised by Jörgensen's conclusions above noted. Added to these difficulties were those which he himself created by the relatively slight attention given by him in his monograph to the Tintinnidæ, by his wide concept of the genus Tintinnus, his return of Amphorella to Tintinnus, and by his unique method of establishing a trinomial system.

Brandt's (1907) idea that wall structure had great systematic value seems to be responsible for his failure to recognize the very great diversity of form and morphology of the loricæ of Tintinnus as he conceived it. He compressed into this genus all species with a hyaline,

structureless wall without secondary structure, and generally without evidence of primary structure. In consequence of this, the genus Amphorella established by Daday was compressed, along with some of the species of our genus Steenstrupiella, into the now already greatly diversified genus Tintinnus, as the "Formenkreis von *Tintinnus amphora* und *Tintinnus steenstrupi.*" Into the first part of this heterogeneous complex he placed three diverse species: *T. amphora* Claparède and Lachmann, with truncate aboral end; *T. acutus* Schmidt, with pointed aboral end; and *T. palliatus* Brandt, with pyramidal aboral end and a mantle. The first of these constitutes the genus Amphorella, as emended by Jörgensen; the second we (1929) referred to our genus Amphorellopsis, with a pointed instead of truncate aboral end; and for the third, which is wholly different in morphology from all other Tintinnidæ, we erected a new genus, Brandtiella.

In the *Tintinnus amphora* form cycle, thus shown, there remained only four systematic units, *T. amphora* "typisch", *T. amphora* var. *quadrilineata* (Claparède and Lachmann), *T. amphora* var. *dadayi*, and *T. amphora* var. *c.* Brandt (1907) did not accept Jörgensen's (1899) amalgamation of Claparède and Lachmann's *T. amphora* and *T. quadrilineatus.* He recognized both in the material of the Plankton Expedition, confirmed the three-finned structure of both previously noted by Jörgensen for *quadrilineatus*, accepted the validity of *dadayi*, though he did not find it in his material, and reduced it to a variety of *T. amphora.* In our *Conspectus* (1929) we followed Brandt (1907) in recognizing both *amphora* and *quadrilineata*, but gave them both specific status, limiting *amphora* to Claparède and Lachmann's original figure and calling Brandt's (pl. 69, figs. 3, 4, 7) figures of *quadrilineata* a new species, *Amphorella infundibulum;* assigned Brandt's "typical" *amphora* to the species *A. brandti*, following in this Jörgensen's (1924) rejection of Brandt's view as to the allocation of these loricæ; rejected *T. dadayi* Jörgensen by reducing it to a synonym of *A. quadrilineata*, following Jörgensen (1924) in this; and raised Brandt's var. *c* to specific status as *A. calida.*

Jörgensen's (1924) conception of the genus Amphorella was based primarily on the closed aboral end and thin, simple wall, regardless of the shape of the lorica and of the presence or absence of fins. This resulted in his inclusion in Amphorella of the following other genera later recognized by us (1929), namely, Steenstrupiella, including *gracilis* (his fig. 19), *intumescens* (his fig. 18), and *steenstrupii* (his fig. 16); Amphorellopsis, including *tetragona;* Dadayiella, including *acutiformis* (his fig. 22d), *ganymedes* (his fig. 22a), *bulbosa* (his fig. 22b), *jörgenseni*

(his fig. 22c), and *pachytœcus* (his fig. 20); Ormosella, including *trachelium* (his fig. 21); Canthariella, including *pyramidata* (his fig. 17); and Craterella, including *oxyura* (his fig. 23), *torulata* (his fig. 24), and *urceolata* (his fig. 25a, b). Jörgensen (1924), in his monograph, continues within Amphorella, as conceived by him, his earlier (1899) confusion of *amphora* with *quadrilineata;* recognizes the small form, our *minor,* as *quadrilineata* var. *minor;* renames Laackmann's (1909, pl. 50, fig. 12) *amphora* var. *dadayi* quite correctly as a new species, *laackmanni;* and reduces his earlier (1905) *dadayi* to a synonym of *quadrilineata.* Laackmann specifically states that he found at the aboral end of all loricæ of his var. *brasiliensis* a biconvex or plano-convex structure caused by a parting of the inner and outer laminæ of the region regarded by us as the truncated tip, as shown in his figure (1909, pl. 50, fig. 12). We have not seen this, no one else has figured it, and it may be only a misinterpretation of the slight obliquity of this region, which does sometimes occur. This so-called structure is probably only the outline of the obliquely viewed truncated aboral end.

The synonymy of this perplexing situation is largely included in the preceding historical discussion. The genera to which some of the species belong which were included in Amphorella by Jörgensen (1924) are Amphorellopsis, Canthariella, Craterella, Dadayiella, Ormosella, and Steenstrupiella (see K. and C., 1929, p. 307). This confusion occurs because he did not use the truncated aboral end as a generic character.

Amphorella belongs in the subfamily Tintinninæ differing from the Salpingellinæ in the presence of the closed aboral end, and from the Stelidiellinæ in the absence of a very well developed nuchal groove or a suboral ledge. The genus is one of the less specialized ones in the Tintinnidæ, being of relatively small size and lacking marked differentiation in the anterior end. Its only highly specialized features are the longitudinal fins and the truncate aboral end. It offers a starting point for the evolution of Amphorellopsis and Odontophorella by the contraction of the aboral end to a point, and of Albatrossiella and Dadayiella by the elongation of the aboral end in a horn and by the suppression of fins or their reduction to striæ.

Includes 6 species: — *quadrilineata,* the type species, since it is the oldest in the genus and has page priority; and *amphora, calida, infundibulum, laackmanni,* and *minor.*

Amphorella amphora (Claparède and Lachmann) Daday

Plate 28, fig. 20

Tintinnus amphora Claparède and Lachmann, 1858, p. 199, pl. 8, fig. 3; Kent, 1882, p. 606, pl. 31, fig. 12; Bütschli, 1889, pp. 1734–1735, pl. 70, fig. 4; Delage and Hèrouard, 1896, p. 467, fig. 793; Brandt, 1906, p. 33, pl. 69, fig. 6; 1907, pp. 433–434, 454.

Amphorella quadrilineata var. *brandti* Jörgensen, 1924, p. 18.

A. amphora, Daday, 1887a, pp. 157, 208, pl. 1, fig. 3; 1887b, pp. 534, 535, 559, pl. 18, fig. 4; K. and C., 1929, p. 309, fig. 586.

A. brandti, K. and C., 1929, p. 309, fig. 588.

A. quadrilineata, partim, K. and C., 1929, p. 311 (for fig. 587 see *A. quadrilineata*).

Lorica fairly large and vase-like, with a very widely flaring, distinctly set-off collar; 2.45–2.53 (2.47) o.d. Collar a low, inverted, and truncate cone (75–80°), outwardly concave, about 0.2–0.3 o.d. in length, circular in cross section at all levels. Nuchal region 0.60–0.68 o.d. in diameter. Bowl elongated, sack-like, its greatest width (0.79–0.88 [0.82] o.d.) at posterior 0.29–0.32 t.l.; increasing evenly and regularly in diameter from throat to widest level, at first as a short cone of 7–9°, and then, due to fins, a truncated pyramid with convex sides to widest level. Posterior section, 0.29–0.32 t.l., an inverted pyramid of 47–50°. Antapex squarely truncated, 0.12–0.20 o.d. in diameter; sometimes indented in its center. Fins 3, longitudinal, equidistant, low, 0.57–0.75 t.l., arising from truncated aboral end as strong ridges, becoming striæ-like above middle of course, and tending to be deflected to right (3°) in oral third. Wall without trace of prismatic structure, thickened in neck region, elsewhere uniform and only half as thick. Animal rather small, with 2 oval macronuclei.

Three loricæ: L., total, 103–119; fins, 65–85. D., oral, 42–47; neck, 25–32; bowl, 36–40 μ.

See *A. quadrilineata* for earlier history. Kent's figure (1882, pl. 31, fig. 12) is a copy of Claparède and Lachmann's. We (1929, p. 309) included Bütschli's figure (1889, pl. 70, fig. 4), called *Tintinnus amphora*, along with its reproduction by Delage and Hèrouard (1896, fig. 793), in synonymy of *A. amphora*. By an oversight in proof-reading, a paragraph commenting on the presence of secondary structure in Bütschli's lorica, on which he based a fanciful relation of Tintinnus to Cyttarocylis, was transferred from the text of *A. amphora* to that of *A. brandti*. Since no one has ever rediscovered such a lorica, Bütschli's figure may

be regarded as merely an aberrant *A. amphora*, pending an opportunity for further investigation.

At 4 stations, in Drift; at 73–81 (77.9)°; 4 loricæ. Type locality off Glesnæsholm, near Sartoröe, Norway (Claparède and Lachmann, 1858, pl. 8, fig. 3), where it may be an invader with Gulf Stream water.

Amphorella minor Jörgensen

A. quadrilineata, Hofker, 1931b, pp. 384–385, fig. 80.

Lorica short, asymmetrically vase-shaped, with very widely flaring, abruptly set-off collar, and little local nuchal constriction; 1.7–3.3 (2.4) o.d. Collar a low, inverted, truncated cone of 40–70°, outwardly convex above, becoming slightly concave below, circular in cross section at all levels, 0.2–0.3 o.d. in length. Nuchal diameter 0.60–0.65 o.d. Bowl creased bag-shaped, with its greatest width (0.71–0.95 [0.85] o.d.) in posterior 0.2–0.3 t.l., increasing in diameter from distinct throat to this level, first as a convex cone of 10–15° and then pyramidal posteriorly. Posterior bowl 0.2–0.3 t.l., a rounded truncated pyramid of 45–62°. Antapex squarely truncated and 0.1–0.2 o.d. in width. Fins 4, low, longitudinal, leiotropic, with turn up to 0.5 o.d., or rarely slightly dexiotropic, equidistant, 0.6 or more t.l., arising from truncated aboral end as ridges which quickly become decurrent, line-like striæ above. Wall nearly transparent, thickening from oral rim to maximum thickness in nuchal region, much thinner in bowl. Animal with 2 or 4 small ovoidal or spherical macronuclei, 7.5 by 10μ; rather large, occupying 0.5 of lorica.

Six loricæ: L., total, 75–130 (102.8). D., oral, 30–56 (42.6); greatest, 27–42 (36.2)μ.

At 7 stations, viz., at 1, 1, 1, 1, 1, and 2, respectively, in California, Mexican and North Equatorial currents, Panamic Area, Galapagos Eddy, and Drift; at 73–84 (79.1)°; 11 loricæ.

Amphorella quadrilineata (Claparède and Lachmann) Daday

Plate 28, figs. 17–18

A. quadrilineata, partim, K. and C., 1929, p. 311, fig. 587 (see also *A. amphora*).

Lorica slender vase-shaped; 2.1–3.4 (2.9) o.d. Collar a truncated, inverted cone of 35–40°, with some exceptional figures in which it is as much as 78°, probably due to flattening, 0.2–0.5 o.d. in length, sides slightly concave outwardly. Nuchal diameter 0.60–0.74 o.d. Bowl

creased bag-shaped, set off from collar by marked concave nuchal constriction in most individuals or views, but not sharply localized when angles affect outline; inflated to 0.76–1.05 (0.84) o.d. at middle, or at varying levels anterior or posterior to this, but never beyond 0.3 t.l. from middle. Anterior bowl circular in cross section. Lower bowl becoming convex pyramidal by reason of 3 fins, contracting evenly and regularly below level of greatest width to squarely truncated antapex, forming truncated inverted pyramid, the convex sides of which are 3–15°, contracting distally to 30–60°. Antapex squarely truncate, in aboral view subtriangular, with outwardly concave sides between 3 projecting angles, 0.18–0.22 o.d. in width. Daday (1887b, pl. 18, fig. 5) figures it as simply rounded, probably in error. Fins 3, elevated, subequidistant, posteriorly located, longitudinal, anteriorly decurrent, 0.5–0.8 t.l., sometimes either slightly dextrotropic or leiotropic in distal 0.3. Wall thickest in nuchal region, but not uniform in all radii; elsewhere very much thinner. Outline frequently deformed posteriorly by reason of weak wall, which also allows much flattening under coverglass. Lumen of bowl enters narrowly into vertical angles. Animal (figured by Fauré-Fremiet, 1924, fig. 36) with oblique peristome, 18 membranelles without intercalary tentaculoids, peristomal margin with deeply incised lobes; 7–8 longitudinal rows of short somatic cilia; body elongated but when fully extended not reaching far out of lorica; with a short peduncle attached to side of lorica close to aboral end. Daday (1887b) reported 4 macronuclei. In our material there are 2 or 4 oval macronuclei, each 7.5 by 10 μ. One of us (Campbell) has repeatedly found 7–8 oval or irregular nuclei of similar dimensions in nondividing material from La Jolla, California. These possibly represent approaching endomixis, since no new peristomal anlage was present in cytosome.

Twenty-five loricæ: L., total, 111–187 (128.8). D., oral, 39–60 (44.3); expansion, 37–51 (46.7) μ.

A full account of the nomenclatural confusions which have resulted from Claparède and Lachmann's (1858) original error in overlooking the fins on *T. amphora*, and from opinions among authors as to the status of the two species, will be found in Brandt (1907), Laackmann (1909), Jörgensen (1924), and in our discussion of the genus Amphorella, and of *A. amphora*.

At 70 stations, viz., at 5, 6, 12, 1, 1, 11, 3, 2, and 29, respectively, in California, Mexican, Peruvian, South Equatorial and North Equatorial currents, Panamic Area, Galapagos and Easter Island eddies, and Drift; at 66–84 (75)°; 839 loricæ.

39. AMPHORELLOPSIS Kofoid and Campbell

Tintinninæ with lorica with low, bowl-shaped, flaring collar; fusiform bowl; sharply pointed aboral end; 3–6 vertical, or slightly spiral, longitudinal fins extending from aboral end anteriorly for from 0.25 to nearly entire length of lorica; wall hyaline, structureless (except in *A. acuta*); marine. Type species *Amphorellopsis acuta* (Schmidt) K. and C. from the Gulf of Siam.

Resembles Amphorella in general form, but differs strikingly in having an acute or very narrowly blunt antapex instead of a truncated one, and in being proportionately narrower. Resembles Odontophorella in form, but lacks a toothed oral margin and recurved hooks on fins of the latter. Collar resembles that of Steenstrupiella, Albatrossiella, and Salpingella.

Established by us (1929) from species previously assigned either to Amphorella because of general form and closed tip, or to Tintinnus because of homogeneous structure regardless of form. Species thus assigned were *acuta* (Schmidt, 1901) and *tetragona* (Jörgensen, 1924).

Contains 7 species, of which 5, *quadrangula*, *acantharus*, *tropica*, *turbinea*, and *lævis*, previously described (1929) by us, are new, and, with one other, *acuta*, present in Expedition material. The 7 form a series, including *tropica*, *acantharus*, *turbinea*, *quadrangula*, *lævis*, *tetragona*, and *acuta*.

Amphorellopsis acantharus Kofoid and Campbell

Plate 28, fig. 8

Lorica small, stout tack-shaped, tapering aborally, slightly convex conical without median expansion, with conical aboral end; 2.5 o.d. Collar disproportionately large, forming a segment of a truncated, slightly convex cone of 80°, widely flaring, low bowl-shaped, 0.14 t.l. Nuchal diameter 0.6 o.d. Bowl 0.86 t.l., subcylindrical in anterior 0.5; 0.6 o.d. in diameter, contracting gradually posteriorly without distinct shoulder to antapex, distally a slightly convex inverted cone of 32°, with narrowly truncated tip, possibly broken in our specimen. Fins 6, low, vertical, longitudinal, equidistant, extending 0.3 t.l. anteriorly from tip. Wall with Amphorella-like thickening in collar above nuchal region, thinning down to oral rim. Prismatic structure not demonstrated.

L., total, 67; bowl, 57. D., oral, 27; midway, 16μ.

At Sta. 4655; at 65°; 1 lorica.

Amphorellopsis acuta (Schmidt) Kofoid and Campbell

Non *Dadayiella acuta*, K. and C., 1929, p. 320, fig. 609 (see *Dadayiella acutiformis*).

Lorica relatively large, a truncated spindle with an anterior, flaring, trumpet-shaped collar; 2.93–3.77 (3.35) o.d. Oral margin thinning abruptly to sharp edge. Collar 0.09 t.l., with outwardly convex sides, a segment of an inverted truncate cone of 62–65°. Nuchal diameter 0.66 o.d. Bowl elongated, 0.91 t.l., with moderately convex sides increasing posteriorly to 0.7 o.d. a little below middle. Upper bowl a truncated cone of 5° in our lorica, but 12° in Schmidt's (1901). Bowl circular in transection anteriorly and triangular posteriorly. Aboral end a pyramid of 40°, with slightly convex sides, contracting evenly to pointed antapex. Fins forming 3 vertical, equidistant angles 0.55–0.71 (0.61) t.l., making the vertical margins of 3 facets of pyramidal aboral region. Wall, with greenish cast, thicker in throat, thinning out in bowl above antapex and in angles.

Two loricæ: L., total, 150–155. D., oral, 41–57; midway, 23–25μ.

Loricæ from Sta. 4627 at surface temperature of 81° larger (150–155μ) than Schmidt's (1901) from Gulf of Siam (91–98μ) and Brandt's (1907) (115–150μ), suggesting a temperature relationship.

Described by Schmidt (1901) from the coast of Siam as *Amphorella acuta*. Brandt (1907) assigned it to Tintinnus. Jörgensen (1924, pp. 17, 22) used the name *acuta* in his *Amphorella ganymedes* f. *acuta*. By an extension of Article 11 of the Code of Nomenclature to apply to names of forms as well as to those of subspecies, Jörgensen's name *acuta* becomes a homonym of *acuta* Schmidt, and was therefore not available in Amphorella for his new form. Neither could it be utilized as a species name in Dadayiella when we (1929) transferred Jörgensen's (1924) forma *acuta* to Dadayiella and raised it to specific rank.

At Sta. 4627 in Panamic Area; at 81°; 1 lorica.

Amphorellopsis lævis Kofoid and Campbell

Plate 28, figs. 3, 4

Lorica tall, slender vase-shaped; 3.23–4.20 (3.37) o.d. Collar short, funnel-shaped, 0.21 t.l., a segment of an inverted cone of 32°, with sides slightly concave outwardly, especially above anteriorly, but becoming angular below. Nuchal diameter 0.8 o.d., circular in cross section. Bowl truncated fusiform, 0.79 t.l., with greatest diameter (1.1–1.2 o.d.) midway of length; with sides outwardly symmetrically convex. Upper

bowl a segment of a convex cone of 18°. Lower bowl convex subconical, contracting to an inverted cone of 60° near acute antapex. Lengths of two cones subequal. Bowl pentagonal in cross section, due to 5 subequal, equidistant, thin, blade-like fins extending from near oral margin to antapex, meeting in aboral point, 0.98 t.l., widest near middle of lorica; formed by folds decreasing in thickness outwardly to a thin, solid blade, with maximum elevation at middle of 0.5 of radius, becoming decurrent distally both above and below this level. Wall homogeneous, thickest near oral margin and progressively thinner posteriorly. Animal with 2 oval macronuclei, each 5 by 7 μ. Cytosome large, 70 μ in length, even when contracted.

Three loricæ: L., total, 77–125 (101.0); fins, 87–115 (102.3); bowl, 76–105 (90.3); collar, 10–23 (14.0). D., oral, 22–39 (30.0); midway, 26–29 (28.7) μ.

At 4 stations, viz., at 1, 2, and 1, respectively, in California Current, Panamic Area, and Drift; at 71–80 (76.5)°; 4 loricæ.

Amphorellopsis quadrangula Kofoid and Campbell

Plate 28, fig. 15

Lorica minute, subcylindrical, tube-shaped; 3.67 o.d. Oral rim incurved. Collar very low, flaring abruptly, with convex sides, a segment of an inverted truncated cone of 34°, 0.07 t.l. Bowl 0.92 t.l., subcylindrical and straight-sided in anterior 0.75, tapering 3–4°; posteriorly a convex cone of 25°, increasing to 45° near antapex. Aboral end with a cylindrical projection 0.05 o.d. in length, and blunt tip. Fins 4, subequal, subequidistant, wide, blade-like, with slight leiotropic spiral of 6°, 0.9 t.l., with peripheral margins very convex, widest (0.31 o.d.) 0.25 of their length from antapex, and decurrent at both ends. Wall thickest in collar, thinner in bowl. Animal with 2 large oval macronuclei, each 7 by 9 μ.

L., total, 81. D., oral, 22; bowl, 20 μ.

At Sta. 4737, in Drift; at 81.5°; 1 lorica.

Amphorellopsis tropica Kofoid and Campbell

Plate 28, fig. 9

Lorica minute, subcylindrical, slender chalice-shaped; 3.26 o.d. Collar reduced almost to extinction, flaring only slightly from bowl, a segment of an inverted cone of 13°, with barely concave sides; 0.12 t.l.

Nuchal diameter 0.9 o.d. Bowl truncate fusiform; its anterior 0.5 a truncated cone of 5°; posteriorly an inverted, blunt-pointed, slightly convex cone of 23°, increasing to 40° aborally; with greatest diameter slightly below middle, equaling oral diameter. Fins 4, blade-like, vertical, subequal, equidistant, longitudinal, decurrent at both ends and without spiral deflection, arising at antapex and reaching greatest width (0.3 o.d.) at 0.4 of their length above antapex. Wall very hyaline, with a greenish cast, uniform in thickness. Animal with 2 ovoidal macronuclei, each 6 by 9 μ.

L., total, 85. D., oral, 26; midway, 23 μ.

At Sta. 4740, in Drift; at 81°; 3 loricæ.

Amphorellopsis turbinea Kofoid and Campbell

Plate 28, fig. 6

Lorica elongate-ovoidal or tall top-shaped, with deep nuchal constriction obscured by wide fins; 3.59 o.d. Oral margin sinuous, with 3 equidistant, low, rounded elevations at upper ends of 3 fins, with interdental regions upwardly concave and suboral wall incurved, recalling the similar margin characteristic of Salpingacantha. Collar low, outwardly convex, bowl-shaped; 0.12 t.l.; swollen above middle in suboral bulge of 1.2 o.d., with flat sides sloping 20° inwardly above toward axis, below bulge a segment of an inverted cone of 30°. Bowl elongate ovoidal, 0.88 t.l., with greatest diameter (1.83 o.d. including fins) midway. Upper bowl a segment of a cone of 23°; the lower, convex, an inverted cone contracting to 110° at aboral end. Aboral tip with tiny, acute spinule 0.08 o.d. in length. Fins 3, vertical, equidistant, very broad, and subequal, extending anteriorly from just above antapex, to become decurrent on swollen suboral bulge of collar. Wall non-prismatic, thickest in collar, thinning to half this in bowl. Animal seen with 4 (2 in division?) globular macronuclei, each 10 μ in diameter, grouped in two pairs, one anterior, the other posterior. There are many large vacuoles.

L., total, 68. D., oral, 19; bulge, 22; bowl, 32 μ.

At Sta. 4724, in Drift; at 79°; 1 lorica.

40. ODONTOPHORELLA Kofoid and Campbell

Tintinninæ with lorica amphora-shaped, 3.37–4.91 o.d. in length; oral rim toothed; collar Amphorellopsis-like, flaring, set off from bowl by a nuchal constriction; bowl truncate fusiform in shape; 5 sub-

vertical fins, each with marginal spines; antapex pointed, tip closed; length 125–153μ; marine.

A single species, *Odontophorella serrulata* K. and C., is the only known species of this unique genus, and is its type species. Type locality Sta. 4721 in Drift.

This genus most closely resembles Amphorellopsis, with which it has in common amphora-shaped lorica, short, flaring, low, bowl-shaped collar, and subvertical fins. The strongly developed secondary structure of the wall occurs also in *Epicranella prismatica*. In neither of these cases is this structural feature found elsewhere in any of the nearest relatives, but only in distantly separated families.

Odontophorella serrulata Kofoid and Campbell

Plate 28, figs. 7, 10, 19

Lorica amphora-shaped; 3.37–4.91 (3.91) o.d. Oral margin with 18 low, angular, and upwardly directed teeth. Collar distinctly set off, 0.25 o.d. in length; flaring, low, bowl-shaped, forming a segment of an outwardly convex, truncated inverted cone of 55°, with a slight suboral bulge. Nuchal region distinctly constricted, 0.75–0.80 o.d. Bowl elongated, truncated fusiform in contour; 0.88–0.93 (0.92) t.l., or 3.25 o.d. in length; 0.91–1.20 (0.93) o.d. in diameter midway of its length, and 1.0–1.2 o.d. in diameter at its widest level at 0.60–0.65 t.l. from oral margin. Upper bowl a segment of a truncated cone of 7°, 2 o.d. in length. Lower cone with outline of nose of a bullet, or a convex cone increasing to 60° near antapex. Bowl circular in cross section in anterior half, as is also the collar, but pentagonal posteriorly. Fins 5, thin, equidistant, subequal, extending from pointed antapex anteriorly for 0.9 t.l. above, widest (0.03–0.05 their length) at 0.30–0.35 their length from antapex near level of greatest diameter of bowl; decurrent above and below with an anterior dexiotropic deflection of 5°. There are 3–13 (9.6) short, tapering, aborally recurved marginal spines, located on outer edges of fins near level of greatest diameter of bowl, extending not more than 0.12 t.l. above and below that level, giving a very characteristic appearance to lorica. Wall with somewhat greenish cast; thickest at nuchal constriction, thinner above, and uniformly thin below. An irregular polygonal meshwork of secondary prismatic structure prominently displayed in wall (Plate 28, fig. 10). Meshes 5–10 between fins, in single layer with longest diameters 4–15μ. Primary prisms not distinguished within meshes of secondary reticulum. Animal with 2 large

oval or spheroidal macronuclei, each 6 by 10 μ or 8 by 8 μ, one diagonally above the other in upper 0.3 of cytosome.

Four loricæ: L., total, 128–153 (137.6); fins, 120–142 (126.6). D., oral, 26–45 (35.6); midway, 27–40 (33.0) μ.

Loricæ from Sta. 4721 at surface temperature of 75° are distinctly smaller (128–135 μ) than those (144–153 μ) from cooler (69°) stations.

At 3 stations in Drift; at 69–79 (74)°; 6 loricæ.

41. ALBATROSSIELLA Kofoid and Campbell

Tintinninæ with minute and greatly elongated lorica, 5.95–6.50 o.d. in length; collar low, funnel-shaped, an inverted truncated cone; bowl subcylindrical, contracting posteriorly in a short aboral cone to a very long, slender, aciculate aboral spine, 0.6–0.7 t.l.; no fins, striæ, or facets; wall hyaline, homogeneous; marine. Type species *Albatrossiella filigera* (Laackmann) K. and C. from South Equatorial Current of Atlantic.

An aboral spine of the proportionate length (0.6–0.7 t.l. or 6 o.d.) recorded in Albatrossiella is not found in any other Tintinnoinea. The flaring collar of the two best known species of the genus recalls that of Canthariella, Odontophorella, and Steenstrupiella, where the flare is also of generic value, but is only specific in Amphorellopsis. The lorica is not striated or faceted, as in Amphorellopsis and Dadayiella, and lacks the fins of Odontophorella, Amphorella, and Amphorellopsis.

Established by us (1929) to include three species, *filigera* (Laackmann), previously assigned to Undella, and *minutissima* (Meunier) previously assigned to Amphorella, and one new species from the collections of the Expedition, *agassizi*.

We take pleasure in designating this genus after the United States Bureau of Fisheries S.S. "Albatross", whose services for many years, from August 19, 1882 to October 29, 1921 in the exploration of the sea, in this and other Expeditions, have contributed greatly to our scientific knowledge of the oceanic marine fauna, and especially of the oceanography and biology of the Pacific.

Much uncertainty attaches to the status of *A. minutissima* (Meunier) K. and C. It is exceedingly minute, perhaps the smallest species in the Tintinnoinea. It may not even belong to the Tintinnoinea, but be only a fragment of some other organism, such as a pelagic crustacean. We have given its characters no weight in our treatment of the genus.

The similarity between loricæ of species of this genus in elongation

of aboral horn to *Protorhabdonella mira* and *Rhabdonella chiliensis* is noteworthy; in both longitudinal striæ characteristic of the Rhabdonellidæ are found along with the elongated horn of Albatrossiella, but such elongation does not occur in the other species of genera to which they belong, and Albatrossiella lacks striæ.

Albatrossiella agassizi Kofoid and Campbell

Plate 29, fig. 11

Lorica greatly elongated, slender goblet-shaped; 5.95 o.d., with very long, very slender aboral spine. Collar funnel-shaped, with slightly convex sides, a segment of a low, inverted, truncated cone of 50°; 0.33 o.d., or 0.06 t.l. Nuchal diameter 0.66 o.d., but nuchal area not separated from bowl by shoulder. Bowl shaped like a short test tube, forming but a small part (0.37 or 2.4 o.d.) of t.l. Upper bowl a truncated cone of 6°, 0.66 of bowl in length, with greatest diameter (0.7 o.d.) in lower third. Lower bowl quickly contracting to an inverted convex cone increasing to 50° in lowermost portion. Aboral spine very long, 4 o.d., or 0.6 t.l., aciculate and very deformable; its posterior extremity bent in our specimen. Its uppermost 0.12 a segment of a truncated inverted cone of 15°, below for 0.63 its length a cylinder 0.08 o.d. in diameter. Its distal 0.24 a slender cone of less than 5°. Aboral end closed, needle-shaped. Wall uniform in thickness. Lumen enters long aboral spine. Animal with 2 oval macronuclei, each 8 by 15μ, and a single [?] spherical micronucleus.

L., total, 119; collar, 7; bowl, 44; spine, 68. D., oral, 20; nuchal, 12; bowl, 14; spine, 1.5μ.

At Sta. 4742, in South Equatorial Current; at 77°; 1 lorica.

42. DADAYIELLA Kofoid and Campbell

Bursaopsis, *partim*, K. and C., 1929, pp. 303–305 (see also Tintinnus and Proamphorella).

Tintinninæ with a tall goblet-shaped lorica; oral rim crenulate-angled; collar set off by slight nuchal constriction, if at all, flaring but little except in *D. pachytœcus;* bowl campanulate, with little if any inflation, contracting to an inverted conical or ovoidal aboral end; pedicel distinctly set off, not exceeding oral diameter in length, narrowly conical or subcylindrical; aboral end acute, blunt, with or without distal bulbous enlargement; wall thin, structureless except in

thickened wall of pedicel; vertical ribs in collar, also on pedicel in some species, and on bowl in a few species, giving rise to intercostal facets; marine. Type species *Dadayiella ganymedes* (Entz, Sr.) K. and C., a cosmopolitan oceanic species, the first described of this strikingly unique genus.

Some characters in the ensemble which distinguish Dadayiella from other Tintinnidæ occur singly in other genera. The faceted collar is found in Salpingacantha, but is less developed there and follows its own line of higher differentiation. A faceted bowl is found in all species of Ormosella. Surface fins characterize the posterior end of Salpingella, but are longer and wider than those of Dadayiella; they occur also in Albatrossiella, and some species of Ormosella. Vertical ribs and facets occur in Bursaopsis, Canthariella, Ormosella, and Steenstrupiella. These ribs are homologous with the fins of Amphorella, Amphorellopsis, and Odontophorella. The development of the knob in the lower end of the pedicel with an aboral spine below it does not occur elsewhere in the Tintinnidæ, though prevalent in the Xystonellidæ and in Rhabdonellopsis. The expansion of the tip of the aboral end in a feebly developed knob without a spine below is seen among the Salpingellinæ in Daturella and in one species only of Salpingella, *S. alata.*

Established by us (1929) for species formerly included in Tintinnus and Amphorella, which have a ribbed collar, no distinct nuchal angle, and a distinct pedicel.

The first species described was *Tintinnus ganymedes* (Entz, Sr., 1884, p. 409, pl. 24, figs. 17–18), later transferred by Daday (1887b) to Amphorella. Brandt (1906, 1907) returned *ganymedes* to Tintinnus and described *bulbosa* as *T. bulbosus* with a var. *a.* We separated *D. bulbosa* (Brandt), as does Brandt, (1907), from *D. ganymedes,* and do not unite them as does Jörgensen (1924). We include in *D. bulbosa* all elongated loricæ lacking the tapering pedicel which characterizes *D. ganymedes,* and which exhibits more or less development of a bulbous enlargement without lateral spikes. We include the unfigured *Amphorella ganymedes* var. *cylindrica* Daday (1887b) in *D. ganymedes* and not in *D. bulbosa,* as did Brandt. We treat as one species, namely, *D. curta,* a group of shorter loricæ of markedly different proportions but containing both bulbous and tapering pedicels, not separating these forms as species for lack of adequate material to show the range of variations. We separate also as a distinct species, namely, *D. jörgenseni,* a lorica with a laterally spiked bulb. The lorica from Naples described by Brandt (1907) in *T. bulbosa* var. *a* we regard with Brandt

as an anteriorly incomplete lorica. The presence or absence of a terminal spinule in *D. bulbosa* is not, in the light of the known variations in that species, a valid systematic distinction. *Amphorella pachytœcus* (Jörgensen, 1924, p. 21, fig. 20) belongs to this genus near *D. cuspis* by reason of its oral striation and facets. This species, with ribs running nearly to the anterior end of the bowl, connects up the aberrant *D. cuspis* with ribs and facets running lengthwise over the whole lorica, and thus completes an orthogenetic development of the ribs in Dadayiella.

Contains 8 species, of which 5 are present in Expedition material; of these 5, 3 are new and 2 are present in Expedition material. Subdivided into 2 series: the *ganymedes* series, including *ganymedes, pachytœcus,* and *cuspis;* and the *bulbosa* series, including *acutiformis, curta, bulbosa,* and *jörgenseni.*

Dadayiella acutiformis nom. spec. nov.

Plate 29, fig. 4

D. acuta, K. and C., 1929, p. 320, fig. 609.
Non *Amphorellopsis acuta,* K. and C., 1929, p. 315, fig. 598.

Lorica tall, slender goblet-shaped, with a distinct pedicel; 2.60–3.49 (3.04) o.d. Collar set off from bowl by slight flare and limits of ribs, which in some loricæ extend beyond nuchal constriction for short distance on bowl; faceted with 8 or 16 equal and outwardly concave facets supported by intervening ribs. Facets arising 0.16–0.30 t.l. below oral rim, less well developed posteriorly. Collar a truncated segment of a concave cone of 8–15°, rarely 20°. Nuchal diameter 0.9 o.d. Bowl inverted campanulate, 0.63–0.71 t.l., circular in cross section except in faceted anterior part, with greatest diameter (0.98–1.00 o.d.) a little above middle of total length. Upper bowl subcylindrical, 0.5 length of bowl in length. Lower bowl shaped like nose of a bullet posteriorly, tapering as a convex cone, increasing to 60° aborally, passing abruptly into pedicel. Pedicel cylindrical above or conical (10°), 0.13–0.17 t.l., with 8 very low ribs on surface of upper end. Aboral end abruptly acute. Tip a short inverted cone of 50–90°. Upper end of terminal cone sometimes slightly enlarged. Wall with greenish tinge, very thin, uniform in thickness. Cavity penetrating nearly to tip of closed pedicel. Animal exceptionally large, completely filling lorica, attached at one side of lower end of bowl.

Ten loricæ: L., total, 82–103 (89.0); collar, 12–16 (13.6); bowl,

52–74 (62.2); pedicel, 11–15 (13.0). D., oral, 25–30 (27.6); bowl, 25–29 (27.7) μ.

Described by Jörgensen (1924, pp. 17, 22, fig. 22d) as *Amphorella ganymedes* var. *a tenuicauda* forma *acuta*. Its form is distinctive and not, in our material, intergraded with that of *D. ganymedes*. We (1929, p. 320) gave it specific status in Dadayiella. The name *tenuicauda* is therefore placed in the synonymy of *ganymedes*. Confusion arises from the fact that Jörgensen divided the species *Amphorella ganymedes* into two varieties, var. *a tenuicauda* and var. *bulbosa*, and did not apply the name *ganymedes ganymedes* to either of them. The former is, therefore, synonymous with *D. ganymedes*. His forma *obtusa* we also refer to *D. ganymedes*. The forma *acuta* of Jörgensen's *Amphorella ganymedes* var. *a tenuicauda* is clearly a different species. It requires, however, a new name, since Schmidt (1901, pp. 184, 185, fig. 2a-c) had already applied the name *Amphorella acuta* to a very different species which we (1929, p. 315) assigned to Amphorellopsis. The first of these names, *acuta*, therefore, according to Article 35 of the International Code of Zoological Nomenclature, belongs to *Amphorellopsis acuta*, and the present species, which we (1929) called *D. acuta*, therefore requires a new name. This we now designate as *Dadayiella acutiformis* nom. sp. nov.

At 26 stations, viz., at 1, 4, 16, 1, and 4, respectively, in California, Mexican, Peruvian, and South Equatorial currents, and Panamic Area; at 66–84 (72.4)°; 274 loricæ.

Dadayiella bulbosa (Brandt) Kofoid and Campbell

Plate 29, fig. 2

Tintinnus bulbosus, var. *a* Brandt, 1906, p. 33, pl. 70, fig. 3; 1907, pp. 413, 456.
Amphorella ganymedes, Hofker, 1931b, p. 384, fig. 79.

Lorica tall, very slender goblet-shaped; 3.52–3.62 (3.60) o.d. By comparison with other species the short, striate, faceted, slightly flaring anterior region is called a collar. Collar a segment of a truncated, slightly concave, inverted cone of not over 6°, 0.75 o.d. in length; with its surface divided into 18 flat, subequal, vertical facets by as many rod-like ribs, which may or may not project slightly above oral rim. Ribs arising 0.12–0.15 t.l. below rim, thickest midway. Nuchal diameter 0.95–0.98 o.d. Bowl inverted, elongated, campanulate; slightly expanded, with greatest diameter (about 0.98 o.d.) at 0.3–0.4 t.l. below oral rim. Lower bowl contracting as a convex, inverted cone of 30–37°, 2 o.d. in length. Pedicel 0.22–0.30 (0.24) t.l., inverted coni-

cal (10°) anteriorly but expanding into a bulbous or ellipsoidal knob 0.5 length of pedicel above tip and 0.3 of its length in diameter. Fins (Plate 29, fig. 2) on surface of pedicel, on or above knob, 8 (4) low, vertical, or very slightly dexiotropic, extending up to bowl. Wall uniformly hyaline, without evidence of structural lamellæ in upper part. Fine primary prisms strongly developed in pedicel in 3–4 layers, especially near bowl, and again in knob. Wall uniform in thickness in bowl, much thinner in collar. Pedicel with cavity continuing to or beyond knob. Animal with 2 oval macronuclei, each 5 by 10μ, 18 membranelles, and as many tentaculoids (Daday, 1887b, p. 539).

Ten loricæ: L., total, 80–121 (92.4); bowl, 60–87 (70.1); pedicel, 18–34 (23.1). D., oral, 24–27 (25.5); bowl, 24–28 (25.8); posterior expansion, 5–8 (6.4)μ.

We allocate to this species one of Jörgensen's loricæ (1924, pp. 17, 22, 23, fig. 22b) of *Amphorella ganymedes* var. *bulbosa*. We also include in our assignment to *D. bulbosa* Brandt's *Tintinnus bulbosa* var. *a* (Brandt, pl. 70, fig. 3).

At 23 stations, viz., at 1, 3, 12, 4, 1, and 2, respectively, in California, Mexican and Peruvian currents, Panamic Area, Galapagos Eddy, and Drift; at 67–83 (68.3)°; 825 loricæ.

Dadayiella curta Kofoid and Campbell

Plate 29, figs. 3, 6

Lorica small and short, stout, goblet-shaped; 2.56–2.58 (2.57) o.d. Oral rim crenulated between ribs. Collar not set off from bowl by nuchal constriction, differentiated only by ribs forming lateral margins of facets, cylindrical or flaring in an inverted slightly concave truncated cone not over 5°. Facets 14–18, well defined, slightly concave in cross section, subequal, rectangular, 0.24–0.30 t.l., better differentiated orally, fading out gradually on surface of bowl. Bowl stout, campanulate, circular in cross section; flaring below collar in a segment of a truncated cone of 6–10° to widest level midway of length of bowl. Lower bowl contracting below in a very convex cone of 80–90° distally. Pedicel 0.25–0.30 t.l., elongated, narrowly conical (5°), 0.2–0.3 its length in diameter at its base; in some loricæ attenuated and without subterminal bulb. Aboral tip acute, sometimes with a slight bulbous swelling above (Plate 29, fig. 6). Aboral fins 8 (4), low, subvertical, extending up to and even on base of bowl. Because of inadequate material we allocate forms with and without a bulb together as one species. They may, however, form a series of dwarf species with

and without swollen pedicels, like the *D. bulbosa* and the *D. ganymedes* series, and parallel to them. Wall hyaline, homogeneous, of greenish cast, uniform in thickness in bowl and much thinner in collar, lamellæ not demonstrated. Cavity of bowl enters pedicel penetrating nearly to its tip.

Three loricæ: L., total, 64–68 (66.0); collar, 9–11 (10.0); pedicel, 11–17 (14.0). D., oral, 25–27 (26.0); bowl, 26–27 (26.5) μ.

At 4 stations, 1 each in California and Mexican currents, Panamic Area, and Drift; at 72–84 (78.6)°; 4 loricæ.

Dadayiella cuspis Kofoid and Campbell

Plate 29, fig. 5

Lorica small, a tall, slender fluted goblet with gently flaring collar sloping gradually into subcylindrical bowl, and this in turn into conical pedicel; 2.91–3.10 (2.93) o.d. Collar distinguished from bowl by gradual change in slope from scarcely defined nuchal region; an inverted, truncated cone of 30–50°, 0.10–0.16 (0.14) t.l., with concave sides. Upper bowl subcylindrical, 0.5 length of bowl in length, with greatest diameter (about 0.8 o.d.) at throat. Lower bowl an inverted cone of 40°, increasing to 55° at aboral end. Pedicel inverted conical (20°), 0.12–0.18 t.l., and with pointed tip. Facets on sides of bowl, originating faintly near oral rim and continuing subregularly and indistinctly evenly to base of pedicel; flat, with 14 thickened edges, or ribs, acting as more rigid supports and giving 14-sided cross section to bowl. Wall hyaline, homogeneous, with greenish cast; uniform in thickness on bowl, slightly thicker in collar, thinning near pedicel; lamellæ not distinguished.

Four loricæ: L., total, 67–93 (80.0); collar, 7–13 (11.0); bowl, 52–64 (58.0); pedicel, 8–18 (11.0). D., oral, 23–30 (27.3); nuchal, 17–19 (18.0); bowl, 15–18 (16.7) μ.

At 4 stations, viz., at 1 and 3, respectively, in California Current and Drift; at 68–79 (72.5)°; 4 loricæ.

Dadayiella ganymedes (Entz, Sr.) Kofoid and Campbell

Plate 29, figs. 1, 7, 9, 13

Amphorella ganymedes var. *cylindrica* Daday, 1887b, pp. 534, 540.

Cyttarocylis ganymedes, Cleve, 1899a, p. 5.

Non *Tintinnus bulbosus* var. *a* Brandt, 1906, p. 33, pl. 70, fig. 3; 1907, pp. 413, 456 (see *D. bulbosa*).

Lorica tall, slender goblet-shaped, with more (Plate 29, fig. 1) or less (Plate 29, fig. 13) taper in lower part of bowl; 3.37–4.20 (3.77) o.d. Oral rim crenulated with 9–18 crenulations, due to intercostal facets. Collar set off from bowl by a slight nuchal constriction coinciding with lower limit of vertical ribs; flaring slightly, a segment of a concave inverted truncated cone of 8–12°; divided into 9 or 18 flat, subequal, oblong, vertical facets by vertical, equidistant, sometimes alternating, unequal ribs, the primaries more distinct than secondaries. Ribs 0.18–0.24 t.l., projecting as thin rodlets 0.2 o.d. above incomplete (?) oral rim. Bowl tall bell-shaped, circular in transection, its greatest diameter (0.98–1.10 o.d.) at or above middle of total length. Upper bowl subcylindrical or a segment of a truncated cone of 5°. Lower bowl contracting into an inverted cone of 35–40°, the outer contour changing from concave anteriorly to convex posteriorly. Pedicel slender aciculate, forming 0.21–0.32 (0.22) t.l., 0.2–0.4 its length in diameter above, subcylindrical, with acute or blunt tip, with 8 (9) low, longitudinal, sometimes slightly dexiotropic, rib-like fins from base to tip on its surface. In some loricæ (Plate 29, fig. 13) fins not developed and pedicel unusually slender, with only a trace of subterminal enlargement. This lorica is incomplete anteriorly and may represent an aberrant or depauperate lorica formed by a senescent or parasitized individual. Wall without marked lamellæ, with prisms in 3–5 layers in pedicel near its origin. Wall of bowl thin, uniform in thickness at ribs, and thinner in facets. Cavity of lorica continuing nearly to end of pedicel. Ribs appear both on inside and outside of lorica, and are formed independently of, and in advance of intercostal facets. Brandt (pl. 70, fig. 2) figures this species with alternating ribs better developed. This feature also appears markedly in one of our loricæ (Plate 29, fig. 13). In the other lorica figured (Plate 29, fig. 1) only primary ribs appear. Cytosome finely granular and colorless, shaped like a trumpet.

Six loricæ: L., total, 88–105 (98.7); bowl, 69–80 (73.2); pedicel, 17–32 (25.5). D., oral, 25–30 (26.8); bowl, 20–24 (22.2) μ.

The number and development of the anterior facets (9 or 18) suggest a differential action of alternate membranelles in lorica building.

Clearly described by Entz, Sr. (1884), who assigned it to Tintinnus; in this he was followed by Brandt (1907). Daday (1887b) and Jörgensen (1924) assigned it to Amphorella. Jörgensen (1924, fig. 22a) called his lorica *Amphorella ganymedes* var. *a tenuicauda* forma *obtusa*, but did not distinguish the typical variety or subspecies by the name given to the species as a whole. His var. *a tenuicauda* is a typical *D. ganymedes*, in close agreement with the original figure of Entz, Sr. (1884,

pl. 24, fig. 17), except for a slightly more obtuse end. Since there are intergradations between pointed and obtuse aboral ends in *D. ganymedes* without accompanying correlated structural changes of specific character, and since there is an abundance of wall substance in the thickened wall of the pedicel, we do not regard the evidence as sufficient to justify systematic recognition of obtuse and pointed apices. Hence we reduce Jörgensen's *Amphorella ganymedes* var. *a tenuicauda* forma *obtusa* to a synonym of *D. ganymedes*. We also assign to *D. ganymedes* Daday's (1887b, pp. 534, 540) *Amphorella ganymedes* var. *cylindrica*. The length is said to be 99μ and the oral diameter 22μ. Brandt (1907, p. 413) included it in his *Tintinnus bulbosus* var. *a* which we assign to *D. bulbosa*. There is no evidence in Daday's (1887b) account that his var. *cylindrica* had bulbous enlargement in the pedicel, and we therefore place it in the synonymy of *D. ganymedes*.

At 24 stations, viz., at 2, 1, 4, 8, and 9, respectively, in California, Mexican and Peruvian currents, Panamic Area, and Drift; at 66–84 (75.6)°; 43 loricæ.

43. ORMOSELLA Kofoid and Campbell

Stelidiellinæ with goblet-like or campanulate lorica, 2.00–3.21 o.d. in length; oral rim entire; collar distinct, excessively large, low bowl-shaped, or truncated, inverted, often outwardly convex cone; bowl short, stout, with upper part cylindrical or inverted, truncated, conical, and lower inverted conical tapering to spine; aboral spine pedicel-like, slender, inverted conical, 0.2–0.3 t.l., with simple, acute, or bluntly pointed tip; aboral end sometimes with merely a spinule; bowl and spine faceted with 7 or 12 equal, longitudinal, triangular facets; wall hyaline, structureless; marine, in warm seas. Type species *Ormosella cornucopia* K. and C.

Tintinnus conicus was reported by Brandt (1906) as a distinctive species of his *Tintinnus ganymedes* cycle from the Guinea and South Atlantic Equatorial currents. *Amphorella trachelium* Jörgensen (1924) was from the Mediterranean and considered by him as possibly synonymous with *T. conicus*. The striated surface, agglomerated bodies, and aboral spine of *Ormosella trachelium* obviously differ from those of Brandt's figure (pl. 67, fig. 10). All other species in this genus were described by us (1929). All species share the distinct collar, conical, faceted bowl, and aboral contraction, forming a unique, coherent group of similar generic characters.

In Ormosella the collar attains the maximum development found in

the Tintinnoinea. The differentiation of collar from bowl initiated in *Tintinnus bursa* is carried on with increasing flare through Cantharielia, Amphorella, Steenstrupiella, and Amphorellopsis, to Ormosella in which the collar attains the maximum relative size and maximum differentiation from the bowl by nuchal constriction, postmarginal overhang, and inner nuchal ledge. Longitudinal differentiations on the surface of the bowl in the form of striæ in Bursaopsis, posterior striæ in *Cantharielia septinaria* and Steenstrupiella, anterior striæ in Dadayiella, and fins in Proamphorella and Amphorellopsis, are represented in Ormosella by angles separating flattened longitudinal facets. The genus Ormosella forms a connecting link between the Tintinninæ and the Stelidiellinæ and might with almost equal justification be placed in either subfamily.

Contains 7 species, of which 6 are present in Expedition material. Subdivided into 2 series: the *bresslaui* series, including *bresslaui*, *hæckeli*, *trachelium*, *schweyeri*, and *apsteini*, and the *cornucopia* series, including *cornucopia* and *schmidti*.

Ormosella apsteini Kofoid and Campbell

Plate 30, fig. 10

Lorica very slender, much elongated goblet-shaped, with squarely spreading, flaring top; 2.38–3.21 (2.96) o.d. Collar an inverted, truncated cone of 30–50°, 0.1 t.l., with nearly straight sides, with external postdiameter 0.8 o.d., set off from bowl by overhanging shoulder formed by horizontal nuchal shelf, with internal diameter 0.5 o.d. Bowl elongated (2.5–3.1 o.d.), relatively very narrow; with greatest diameter (0.55 o.d.) below collar. Upper bowl 0.66 of bowl in length, cylindrical, 0.55 o.d. in diameter. Lower bowl an inverted, slightly convex cone, increasing to 35° distally, sometimes (Plate 30, fig. 5) slightly concave anteriorly and convex near middle of bowl. Facets 6, subequal, flat in section, triangular in outline, with apices contracting to meet aborally, fading out posteriorly, forming distally a long, aciculate, aboral spine, 0.2–0.3 t.l. Tip needle-shaped. Wall with greenish cast; thinning adorally, thickest in ledge, uniform in thickness in bowl. Cavity entering base of long aboral spine. Animal with 2 (or 4, probably prior to fission) oval macronuclei, each 8 by 12 μ.

Five loricæ: L., total, 100–136 (120.3); collar, 12–15 (13.3). D., oral, 40–44 (41.5); nuchal, 22–26 (23.7) μ.

At 4 stations, viz., at 1, 1, and 2, respectively, in Panamic Area, Galapagos Eddy, and Drift; at 72–80 (76)°; 4 loricæ.

Ormosella bresslaui Kofoid and Campbell

Plate 30, figs. 6, 8

Lorica minute, goblet-shaped, with heavy flaring rim; 2.00–2.57 (2.23) o.d. Collar above an inverted, truncated, slightly convex cone of 28°, 0.2 t.l. Postmargin or nuchal shelf of collar 0.6–0.7 o.d., setting off collar from bowl by a slight shoulder. Bowl subcylindrical in adoral 0.40–0.58 of length, contracting aborally in an inverted concave cone of 45–52°; 1.9–2.0 o.d. in length. Facets 12, obscure, parallel, extending from nuchal level to near end of sharp-pointed aboral spine; flat, with triangular apices coalescing on tip of spine. Bowl weakly 12-sided in cross section. Pedicel a short, conical spine, 0.22 t.l., with basal diameter 0.33 its length, and sharp-pointed. Wall thinning adorally and uniform in thickness in bowl, thickened at base of hollow spine. Cavity extending nearly to tip.

Three loricæ: L., total, 56–85 (72.0); collar, 10–14 (12.7); bowl, 35–54 (46.3); spine, 11–17 (13.0). D., oral, 28–34 (31.7); nuchal, 18–24 (21.7) μ.

At 2 stations in Drift; at 75–79°; 2 loricæ.

Ormosella cornucopia Kofoid and Campbell

Lorica stout tapering campanulate; 2.30–2.57 (2.40) o.d. Collar relatively small, a short segment of a truncated, inverted, convex cone of 5–10°, 0.16 t.l. Postmargin recessed, 0.9 o.d. in diameter, and with distinctly angular internal nuchal ledge, obscured in Brandt's (1906) small sketch. Nuchal diameter 0.88 o.d. Bowl subconical in outline and subpyramidal in contour, 2.1–2.2 o.d. in length, with greatest diameter (0.8 o.d.) in upper 0.3 of bowl. Upper bowl 0.3 of bowl, a truncated, convex cone of 9–12°, with gradual change below. Lower bowl with outline of an inverted cone of 30°, in reality an inverted 7-sided pyramid, heptagonal in cross section. Facets 7, longitudinal, subequal, triangular. Aboral end acute, usually ending in a tiny spinule. Wall with greenish cast, thinning adorally, thickest in lower part of collar and angled ledge, uniform in bowl, and thickening near spinule. Animal with 1 oval macronucleus, 8 by 18 μ. Other species in genus have 2 macronuclei.

Ten loricæ: L., total, 120–127 (123.6); collar, 13–17 (15.3); bowl, 100–106 (102.0); tip, 4–8 (6.0). D., oral, 49–54 (51.1); below collar, 40–45 (41.7) μ.

Brandt (1907) states that there are 2 strong, and 3 or 4 weak, striæ on bowl of his photographed specimen. Since our material in proportions and size is so close to Brandt's, we conclude that because he reports striæ only in the photograph he did not completely interpret either faceted surface or number of facets, and that his striæ are boundaries of the facets which we find. He explicitly states, however, that in specimens closely examined by himself he found no striæ. Jörgensen (1924, p. 22) thinks that this species may be synonymous with his *Amphorella trachelium*, but the latter has striæ on the collar, coccoliths on the surface, and a differently shaped aboral region.

At 17 stations, viz., at 1, 4, 2, 1, 2, and 7, respectively, in the Mexican and Peruvian currents, Panamic Area, Easter Island and Galapagos eddies, and Drift; at 66–85 (73.1)°; 26 loricæ.

Ormosella hæckeli Kofoid and Campbell

Plate 30, fig. 5

Lorica slender, flaring campanulate, with very wide convex collar; 2.10–2.56 (2.19) o.d. Collar low bowl-shaped, a convex, inverted, truncated cone of 50°, sharply delimited from bowl by nuchal angle but without nuchal shelf; its postmargin 0.64 o.d. in diameter and 0.10–0.13 t.l. Bowl faceted, 12-sided in cross section, subconical, 1.4 o.d. in length, with greatest diameter (0.6 o.d.) in nuchal region. Upper bowl 0.5 its length, an inverted truncated cone of 5°, with abrupt change to lower bowl. Lower bowl an inverted cone of 25–32°. Facets 12, subequal, longitudinal, triangular, beginning below collar, with apices meeting near aboral end of bowl. Alternate angles are somewhat more evident than intermediate ones. Aboral spine abruptly set off from lower end of bowl by slight shoulder, tapering to an acute or broadly rounded, blunt point; 0.2 t.l. Wall thickening in lower collar thickest at nuchal border in right-angled ledge, uniform in bowl, thickened at aboral tip. Cavity continuing almost to tip of spine. Animal with 2 oval macronuclei, 4 by 6 μ.

Seven loricæ: L., total, 80–95 (87.0); collar, 13–14 (13.4); bowl, 52–74 (61.3); spine, 8–27 (13.4). D., oral, 37–44 (40.0); nuchal, 22–23 (22.6) μ.

At 5 stations, viz., at 2, 1, and 2, respectively, in Peruvian Current, Galapagos Eddy, and Drift; at 69–75 (72.5)°; 7 loricæ.

Ormosella schmidti Kofoid and Campbell

Plate 30, figs. 9, 11, 12

Lorica large, stout, conical, campanulate, with moderate collar; 2.14–2.45 (2.22) o.d. Collar a cylinder, or a truncated, inverted cone of not over 10°, 0.15 t.l., with straight sides, with lower edge rounded, overhanging bowl 0.05–0.08 o.d. Postmargin 0.95–0.98 o.d. in diameter. Nuchal diameter 0.83 o.d. Bowl an inverted, 7-sided, slightly convex pyramid, in one lorica (Plate 30, fig. 7) slightly swollen near base; 2.0–2.1 o.d. in length, with greatest diameter (0.90–0.95 o.d.) at top or in upper 0.2, contracting gradually posteriorly in outline of an inverted, convex cone of 16–25° in upper 0.5, increasing to 35° in lower half, completely faceted from collar to aboral tip with 7 subequal, triangular facets. No aboral horn. Aboral end subhemispherical in contour, with a radius of not over 0.1 o.d. One lorica (Plate 30, fig. 8) had a very minute spinule on aboral tip. Wall subuniform in thickness in collar and bowl, thickening in ledge, thinning adorally and slightly more aborally in lower bowl.

Eight loricæ: L., total, 125–140 (129.1); collar, 18–22 (19.5); bowl, 105–117 (108.8). D., oral, 57–61 (58.7); nuchal, 47–51 (48.5) μ.

All loricæ in which facets were counted had 7, but it is possible that there are some with but 6 (see Plate 30, fig. 7). Aboral end thinner and weaker than rest of lorica, readily deformable, and sometimes inverted into lumen of bowl.

In our *Conspectus* (1929, p. 323) we stated that *cornucopia* differed from this species in lack of facets. Brandt's figure (pl. 69, fig. 10) of *Tintinnus conicus* (=*O. cornucopia*) does not show either flattened facets or striæ, but in his text (1907, p. 413) he states that there are 2 strong and 3–4 faint longitudinal striæ on main part of bowl.

At 16 stations, viz., at 3, 1, 1, 1, and 10, respectively, in Peruvian Current, Panamic Area, Easter Island and Galapagos eddies, and Drift; at 68–79 (73.1)°; 27 loricæ.

Ormosella schweyeri Kofoid and Campbell

Plate 30, figs. 4, 7

Lorica short, stout goblet-shaped, with disproportionately large collar and much shortened bowl; 1.75–2.50 (2.20) o.d. Collar a short, inverted, truncated cone of 27°, 0.10–0.13 t.l.; with nearly straight sides, or slightly convex, and abruptly contracting at postmargin

0.90–0.95 o.d. in diameter into a narrow, oblique nuchal ledge. Overhang of collar beyond bowl 0.17–0.19 o.d. Bowl short, about 1 o.d. in length, conical, with greatest diameter (0.65 o.d.) at nuchal margin; contracting abruptly aborally. Upper bowl 0.64–0.73 its length, an inverted, convex, truncated cone of 17–22°. Lower bowl a shorter, inverted concave cone of 45–50°, changing gradually into long, aciculate aboral spine, an inverted, concave cone of 8°; 0.22–0.30 t.l. Facets 7, subequal, triangular, longitudinal, contracting aborally in aboral 0.25 of bowl to form aboral spine. Tip either acute or bluntish. Wall with slightly greenish cast, thickened midway of collar and in ledge, thinning aborally in bowl.

Seven loricæ: L., total, 70–113 (93.3); collar, 9–16 (12.5); bowl, 40–53 (48.0); spine, 20–50 (36.0). D., oral, 38–45 (42.3); nuchal, 24–32 (27.8) μ.

At 7 stations, viz., at 1 and 6, respectively, in Peruvian Current, and Drift; at 71–79 (75.3)°; 9 loricæ.

44. BRANDTIELLA Kofoid and Campbell

Stelidiellinæ with lorica elongated phial-shaped, 2.6–3.4 o.d. in length, and enclosed in a gelatinous mantle; suboral region of lorica proper differentiated into an inverted, conical suboral rim and a flaring, angular suboral ring; bowl about 3 o.d. in length, contracting slightly anteriorly, and expanding slightly aborally; aboral end angled, blunt; longitudinal angles most evident on lower half of bowl, usually 3 in number, sometimes bifurcating distally; wall rather thick, minutely prismatic; mantle hyaline, with scattered inclusions, in some loricæ 1.5 diameter of bowl, continuous with lorica at oral rim, suboral ring, and antapex; marine. Type and only species *Brandtiella palliata* (Brandt) K. and C.

Described by us (1929) for one species which Brandt (1907) had assigned to Tintinnus.

Resembles Stelidiella in general form, in having collar separated into two parts, and in purse-like character of its angular aboral end. Differs from Stelidiella in having horizontal angular ring, instead of smooth or fenestrated band, in collar. Lorica has outer mantle composed of hyaline, delicate, flexible, gelatinous substance with imbedded coccoliths, diatoms, or other matter, unlike any other Tintinnoinea. This gelatinous sheath is found in all loricæ and is a constituent part of the wall. It is not marked by coarse prismatic structure, and envelops the remainder of the lorica as a sheath, thinning out on posterior

end. There is no evidence either in its structure or in its variations that it is adventitious. It appears in all loricæ, including those with the animal. It cannot therefore be regarded as a deposit of fæcal detritus from some pelagic organism which had ejected emptied loricæ in its fæces. Its variations in contour indicate a considerable delicacy in the texture of the substance of both sheath and inner wall. Brandtiella has the gelatinous sheath, wholly lacking in Ormosella, and its collar has a suboral ring lacking in Stelidiella. Brandtiella has a collar with two sections, as does Prostelidiella, but in Brandtiella they are outwardly angular and about equal in length, instead of conical and unequal, as in Prostelidiella. The sack-like bowl is also less like a tube and less angular aborally in Brandtiella than in Stelidiella.

Brandtiella palliata (Brandt) Kofoid and Campbell

Lorica sack-shaped, cylindrical anteriorly, with suboral rim and ring, broadly angled aboral end, and an enclosing mantle; 2.60–3.40 (3.02) o.d. Mantle broadly sack-shaped, widest (1.33–1.50 o.d.) below middle, with hemispheroidal or antapically angled aboral end, enclosing entire lorica from oral margin to aboral end, to each of which its outer film is directly attached. Oral margin thin, entire. Collar 0.15 t.l., divided into suboral rim and angular, horizontal suboral ring. Suboral rim an inverted, truncated cone of 12–25° and with length 0.2 o.d., with straight inner and outer surfaces. Suboral ring or ledge a horizontal, angular projection below rim, 1.1–1.8 o.d. in diameter, and 0.16 in length, contracting 27° anteriorly toward rim, and 35° posteriorly toward bowl; optical section an outwardly directed angular (62°) shelf projecting into mantle which is not correspondingly angled, though in some loricæ rim locally distends mantle. Nuchal diameter where suboral rim meets top of suboral ring, 0.9 o.d. Bowl 0.85 t.l., a sack-like structure, constricted above middle at 0.3 t.l. from oral rim to 0.8 o.d. Upper bowl an inverted, truncated concave cone of 7–12°, its greatest diameter (1.00–1.13 o.d.) at 0.7 t.l. from oral rim. Bowl circular in cross section anteriorly and flattened triangular posteriorly where it is laterally concave anteriorly and convex posteriorly on two broad opposite faces, and concave on one or, in loricæ in which one angle bifurcates, on two narrower faces. Aboral end broadly rounded in outline, inflated 15–18°, increasing to 75° posteriorly, with blunt, subangular aboral region. Ridges low, 3 or 4, subvertical, decurrent, longitudinal, 0.3–0.4 t.l., inducing a slight angulation of antapical con-

tour. Ridges, if 4, arranged in two pairs, a concave, narrow triangle being formed between them on two opposite narrower faces, with the apex of triangular fold directed anteriorly, the broader bases of the two triangles meeting antapically. The two broader faces of aboral end convex and their aboral ends angular. Posterior bowl quite deformable, due to softer texture and thinner wall. Wall of lorica proper hyaline, with fine prisms between inner and outer structureless lamellæ; 0.03–0.05 o.d. in thickness in upper 0.50–0.75 of collar and bowl, thickest in angles of collar, much thinner posteriorly in lower bowl. Mantle hyaline, gelatinous, with incorporated diatoms, coccoliths, and other extraneous matter, but in no case with prismatic structure. Brandt's suggestion (1907, p. 436) that some of the particles in it are crystals of sea salt we do not accept, as these inclusions do not have the form of crystals of NaCl and are not dissolved out in distilled water. Certain minute ellipsoidal bodies, if coccoliths, are of exceedingly small types. The periphery of mantle with subregular contour, with minor indications of flexibility and delicacy of structure, enclosing the whole lorica, except oral opening, and thinning out over antapex. Animal with 2 oval macronuclei, each 9 by 15μ.

Six loricæ: L., total, 128–152 (141.3). D., oral, 44–55 (48.3); suboral ridge, 49–60 (53.1)μ.

At 10 stations, viz., at 1, 1, 1, and 7, respectively, in Mexican and South Equatorial currents, Galapagos Eddy, and Drift; at 72–83 (78.5)°; 12 loricæ.

45. PROSTELIDIELLA gen. nov.

Stelidiella, *partim*, K. and C., 1929, pp. 326–377, fig. 624 (for figs. 625–627 see Stelidiella).

Stelidiellinæ with lorica without mantle; collar massive, consisting of a very short inverted suboral rim or cone and long subnuchal cone, with prefenestral and postfenestral rings of Stelidiella represented by slight shoulders; vertical mullions and fenestræ absent; nuchal constriction slight; bowl elongated, not less than 3 times its diameter in length; angles of bowl 3 or 4, longitudinal, slightly leiotropic anteriorly; aboral end broadly angled, bluntly rounded; wall thin, hyaline, and homogeneous; marine. Type and only known species *Prostelidiella phialia* (K. and C.) from Sta. 4662 in Peruvian Current.

We separate this genus from Stelidiella, with which we included it in our *Conspectus* (1929), because of simpler structure and absence of fenestræ on subnuchal cone.

Prostelidiella phialia (Kofoid and Campbell)

Plate 29, fig. 10

Lorica stout scabbard-shaped, with collar of short suboral cone and non-fenestrated subnuchal cone with nuchal constriction between; elongated angular bowl; 3.57 o.d. Oral margin thin, entire. Suboral rim or cone smooth, undifferentiated, 0.014 o.d. in length, a segment of an inverted, truncated cone of not over 5°. Nuchal diameter at base of suboral rim 0.98 o.d. Subnuchal cone truncated, set off from suboral rim by a rounded ledge below nuchal constriction, not by protruding suboral ring, as in Stelidiella. Nuchal cone 0.65 o.d. in length, 1.05 o.d. in diameter at oral end, and 0.8 at aboral, a segment of an inverted, truncated cone of 30°. A sharply marked ledge below constriction, with no ring, separating subnuchal cone from bowl. No fenestræ or vertical mullions in subnuchal cone. Prefenestral and postfenestral rings of Stelidiella represented by slight shoulders at top and bottom of subnuchal cone. Bowl elongated subcylindrical, with diameter at uppermost level 0.32 its length; nearly straight-sided in outline for 3.0 o.d. from that level and rounded aborally, forming an angular (140°), blunt antapex; subcircular in cross section anteriorly, becoming 3- or 4-angled aborally. Fins 3 or 4, rib-like, at oral end, extending sublongitudinally 0.76 total length of lorica, and tending in oral 0.33 to be leiotropic at an angle of 20° anteriorly and a trifle less distally; subequal in length, subequidistant, becoming decurrent at either end; aborally forming a narrow, decurrent fluting not meeting antapically, flutings turning at almost a right angle on antapex; formed by folds of wall. Wall thickest in regions homologous to prefenestral and postfenestral rings, much thinner in bowl.

L., total, 300; suboral cone, 12; subnuchal cone, 40; bowl, 248. D., oral, 85; nuchal, 82; prefenestral ring, 88; bowl, 73μ.

At Sta. 4662, in Peruvian Current; at 69°; 1 lorica.

46. STELIDIELLA Kofoid and Campbell emended

(?) Stellidium Gräf, 1909, p. 144. *Nomen nudum.*

Stelidiella, *partim*, K. and C., 1929, p. 326, figs. 625–627 (for fig. 624 see Prostelidiella).

Stelidiellinæ with stout, scabbard-shaped lorica, 2.7–3.1 o.d. in length; collar massive, inflated, with latticed fenestrations, consisting of a suboral and a subnuchal cone separated by shallow nuchal con-

striction and slight shoulder; bowl 4-angled; aboral end angular; wall hyaline, structureless; marine, in tropical seas. Type species *Stelidiella stelidium* (Biedermann), K. and C.

First seen by Biedermann (1893) from the Atlantic. His specimens of *S. stelidium* were provided with 5–6 triangular teeth. Brandt (1907) used Biedermann's figure, both assigning the species to Tintinnus. Our abundant material from 24 stations provides evidence for the distinction of the genus Stelidiella with three species and the related genus Prostelidiella with one.

Gräf (1909, p. 144) listed as *Stelidium Biedermanni* a tintinnid without description, figure, or citation. It might be inferred from the names that he had in mind either the species originally figured by Biedermann, or was intending later to describe a new species and genus.

A distinctly marked homogeneous genus related to the Tintinninæ, having distinct collar, and fins homologous to striæ. Differs from Prostelidiella, Ormosella, and Brandtiella in having fenestrated lattice-work on collar, and from Brandtiella also in absence of mantle. The most highly differentiated genus in the Stelidiellinæ.

Species of Stelidiella form a short series in degrees of oral differentiation. *Simplex* has a single series of 8 fenestræ and an entire oral margin; *stelidium* adds a toothed oral margin; and *fenestrata* has a double circle of fenestræ, 8 above and 4 below, but differs from *stelidium* in having an entire oral margin.

Contains 3 species, of which 2, both new, are recorded in Expedition material.

Stelidiella fenestrata Kofoid and Campbell

Plate 29, figs. 8, 12

Lorica stout scabbard-shaped, with large dilated collar; 2.8–3.2 (2.9) o.d. Oral margin entire, incurved. Collar convex, much inflated, bowl-shaped, contracting aborally to 0.5 o.d., 0.3 t.l. Suboral cone circular in cross section, 0.12 o.d. in length, a segment of an inverted, truncated cone of not over 10–16°. Nuchal angle scarcely indented. Nuchal diameter equaling oral. Subnuchal cone of two regions separated by distinct shoulder, upper 1.8 times length of lower, which both in dimensions and structure merges gradually into upper end of bowl. Upper part of subnuchal cone a segment of an inverted, truncated, convex cone of 20–31° (26)°, 0.8 o.d. in length. Fenestræ in 2 rows instead of one, each bounded by an outer lattice on surface. Upper, horizontal, prefenestral ring 1.03 o.d. in diameter, and lower,

postfenestral, 0.8. Diameter of lower margin of second row of fenestræ 0.75 o.d. No horizontal ring differentiated at this level. Rings 0.46 o.d. apart, united by 8 longitudinal, subequidistant, subequal, vertical mullions separating 8 subquadrangular, closed fenestræ. Second row of 4 fenestræ with 4 equidistant, subequal, longitudinal, vertical mullions separating 4 subrectangular, closed fenestræ; both rings and mullions raised above surface of fenestræ. Peripheral elements of nuchal lattice triangular in optical section, with an outward, rounded angle of 60°. Bowl 0.5–0.8 o.d. in diameter and 2.0–2.8 o.d. in length; slightly expanded, widest (0.56–0.82 o.d.) at 0.4 its length from aboral end, increasing gradually from throat to widest level. Aboral region 4-sided, with 2 opposite faces becoming wider distally than intervening pair; contracting in outline below widest level within an angle of 5°, increasing to 15° distally. Aboral end rounded, obtuse-angled (135°) in wider faces; on narrower faces contracting somewhat more rapidly and concavely recessed antapically. Fins in 2 pairs, each continuous antapically as a low fluting connecting across aboral end. Each fin runs longitudinally from antapex to second row of fenestræ, bordering two broader faces of bowl; decurrent anteriorly on the four much wider vertical mullions between fenestræ of second row, thickening adorally and becoming thinner aborally. Faces between fins concave in lower portion of lorica but becoming convex above. Bowl in cross section slightly compressed laterally, so that two faces are wider than the other two, in optical section at middle of bowl wider faces 1.5 width of narrower ones and almost flat, narrower ones convex. Wall thickest in subnuchal cone; thinning in bowl. Raised lattice solid, but fins are folds of wall.

Animals with 2 oval macronuclei, each 10 by 7 μ. Two spherical micronuclei (in division) were found, each 1.5 μ across. The 2 macronuclei of this individual were located one above the other near middle of lorica, and above them a new frontal field forming on surface of cytosome. Large granules of lorica-forming substance crowded in cytoplasm near cytostome. Regularity of pattern in loricæ remarkable, showing in constant doubling of fenestræ in lattice from 4 in lower to 8 in upper zone. Numerical relationships of fenestræ (4–8), 4 fins, and quadrilateral form of bowl suggestive of possible correlation with ciliary lines on cytosome, or group action of membranelles.

Seven loricæ: L., total, 275–303 (288.7); suboral cone, 22–28 (24.3); subnuchal cone, 39–48 (44.0); bowl, 210–235 (221.7). D., oral, 86–104 (one of 130, probably flattened, excluded) (93.1); prefenestral ring, 93–120 (99.7); postfenestral ring, 76–100 (84.0); bowl, 53–85 (63.2) μ.

At 18 stations, viz., at 1, 4, 4, 1, and 8, respectively, in Mexican and Peruvian currents, Panamic Area, Galapagos Eddy, and Drift; at 68–85 (75.5)°; 19 loricæ.

Stelidiella simplex Kofoid and Campbell

Plate 29, fig. 14

Lorica short, scabbard-shaped, with relatively long collar and long suboral cone; 2.79–3.10 (2.90) o.d. Oral margin entire, slightly inturned. Collar 0.74–0.77 o.d. in length, 1.6 diameter of bowl. Suboral cone relatively long, 0.3 length of collar in length, cylindrical, or a segment of an inverted, truncated cone of not over 8°. Nuchal angle not recessed. Nuchal diameter equal to oral. Subnuchal cone 0.5 o.d. or 0.15–0.18 t.l., a segment of an inverted, truncated cone of 16–22°. Upper horizontal, or prefenestral, ring 1.10–1.15 o.d. in diameter, and a lower postfenestral 1.03–1.08. Vertical mullions 8, longitudinal, subequidistant, connecting 2 rings and separating 8 quadrilateral, closed fenestræ of interspaces. Both rings and mullions raised above level of enclosed fenestræ. Bowl elongated sack-shaped; 0.79–0.82 t.l., with diameter at uppermost level 0.69–0.78 o.d.; circular in cross section in uppermost level only; its greatest diameter, 0.70–0.78 o.d., scarcely greater than that at its top, at or below its middle; with lateral contour anteriorly slightly and evenly concave; decreasing below widest level with convex contour to 0.4 o.d. at lower end. Antapex truncate, convex and slightly angular on two opposite faces; but on other two bowed up concavely. Fins 4, equidistant, longitudinal, ridge-like, arising at flattened antapex in two pairs, one fin on each angle of bowl, joining postfenestral ring at a low leiotropic angle; thickening at junction and progressively thinner aborally, dividing bowl into 4 intercostal areas in 2 opposite pairs with concave outer faces. Wall pellucid, homogeneous, thin, uniform in thickness in collar for 0.5 its length, and then decreasing, without forming internal ledges, in bowl. Lattice structures massive thickenings of wall not affecting contour of lumen.

Three loricæ: L., total, 264–274 (267.3); suboral cone, 18–26 (24.0); subnuchal cone, 38–45 (41.7); bowl, 195–210 (203.0). D., oral, 85–94 (88.3); prefenestral ring, 88–96 (92.0); postfenestral ring, 72–76 (74.0); bowl, 64–72 (68.7) μ.

At 5 stations, viz., at 1 and 4, respectively, in Peruvian Current and Drift; at 69–81 (73.6)°; 5 loricæ.

STELIDIELLA STELIDIUM (Biedermann) K. and C.

Lorica stout scabbard-shaped, with flaring suboral and subnuchal cones; 3 o.d. Oral margin with 6 low, angular (150°) denticles with concave intervals, slightly inturned. Collar inverted conical, 0.22 o.d. in length, 1.6 diameter of bowl in diameter. Suboral cone short, 0.16 o.d. in length, forming a segment of an inverted truncate cone of 30°. Nuchal angle 125°, nuchal diameter 0.95 o.d. Subnuchal cone 0.42 o.d. in length, a segment of an inverted truncated cone of 35°, with lattice on surface formed by protruding, broadly rounded pre- and postfenestral rings and seven vertical mullions. Rings respectively 1.0 and 0.8 o.d. in diameter. Mullions and rings enclosing 8 subequal quadrilateral fenestræ, each closed by thin panes. Bowl stout, 2.33 o.d. in length, contracting concavely below postfenestral ring to 0.66 o.d., expanding slightly below middle. Aboral end subhemispherical. Fins 4, equidistant, continuous above with postfenestral ring, vertical, forming slightly elevated angles which fade out near aboral end. Faces flattened, even slightly concave. Wall as in *S. simplex*.

L., total, 285; suboral cone, 15; subnuchal cone, 40; bowl, 230. D., oral, 95; prefenestral ring, 95; postfenestral ring, 76; bowl, 55μ.

At 2 stations, in Drift; at 75–79°; 2 loricæ.

47. EUTINTINNUS gen. nov.

Salpingellinæ with narrow, subcylindrical or inverted, truncated, conical lorica, 2.3–10.6 o.d. in length, equally open at both ends; wall hyaline, structureless, or longitudinally wrinkled, never with spiral structure; length 67–650μ, cosmopolitan, pelagic, especially in warmer seas. Type species *Eutintinnus birictus* K. and C. (1929, fig. 634) from Sta. 4574 in California Current.

A virile, dominant genus of Tintinnidæ, shown both in extent of speciation (29 species), more than in any other genus in the family, and in abundance of individuals, but not so evident in evolution of structure. Its morphological diversification in suboral region limited to circumoral teeth (in Odontotintinnus) and thickened, projecting oral rim, and suborally in flaring funnel in subgenus Eutintinnus; in Ceratotintinnus and Odontotintinnus suboral flare almost wholly absent. Shaft modified in *perminutus* series only by slight median or submedian bulge; elsewhere in genus an unmodified cylinder or inverted cone with at most only slight changes in slope. Aboral end even less modified than oral, wholly unmodified in Odontotintinnus, in *pacificus* series of

subgenus Eutintinnus, and, except for *colligatus*, also in *stramentus* series; abruptly contracted in Ceratotintinnus for a short distance as in pedicel of Xystonellidæ; well developed conical aboral funnel, or flare in *macilentus* and *perminutus* series of subgenus Eutintinnus. In *colligatus* there occurs a narrow zone of constriction above the short aboral funnel without parallel elsewhere in the Tintinnidæ.

The open posterior end links Eutintinnus to Salpingella, Salpingacantha, Rhabdosella, Epicranella, and Daturella; more nearly related to the last in form, but lacking entirely any trace of spiral fins and having thin, rigid wall instead of thick, flaccid one; its wall quite like that of Salpingella, but tubular form, lack of longitudinal aboral fins, and wide aboral opening differentiate it from that genus and Salpingacantha; also having, as a rule, less relative development of suboral funnel. *Salpingella laminata* is perhaps the species of Salpingella most closely allied to Eutintinnus. It has the size and form of *E. tubus*, but possesses longitudinal aboral fins lacking in Eutintinnus.

An exceedingly complicated synonymical history has grown up about the name Tintinnus which was used by the earlier writers for nearly the whole of the Tintinnoinea, as, for example, by Claparède and Lachmann (1858). Fol (1881), by the addition of Cyttarocylis, and Hæckel (1878), by that of Codonella, aided in a better delimitation of the increasing number and variety of species. Daday (1887b), by proposing the name Amphorella, still further clarified the complex situation. It is very unfortunate that Brandt (1907), in his great monograph, did not recognize Daday's Amphorella. Jörgensen (1924), who has always retained Amphorella, limited Tintinnus to tubular loricæ with thin, hyaline walls. In our *Conspectus* (1929, p. 329) we restricted Jörgensen's concept of the genus Tintinnus by the exclusion of Daturella, and designated *Tintinnus lusus-undæ* as the type species.

The content of the genus Tintinnus was thrown into confusion by Apstein's (1915) designation of *Tintinnus inquilinus* (O. F. Müller) as the type species of the genus. This action was taken by him in a routine designation of types of a variety of unrelated genera, and with mainly a historical approach to the genus. It was not based on any study of the specific content of the genus as it then existed in literature, nor on the nomenclatural consequences of this selection.

In our *Conspectus* (1929, p. 329) we overlooked Apstein's paper (1915), and designated the type of Tintinnus as *T. lusus-undæ* Entz, Sr., from the Bay of Naples. In the earlier part of our monograph we had followed Fauré-Fremiet (1908b) in placing *Tintinnus inquilinus*

with closed aboral end in Tintinnidium, and also recognized the existence of another species, *Tintinnus apertus*, with an open aboral end and with a pelagic instead of an attached mode of life, first figured by Daday (1887b, pl. 18, figs. 2 and 10) but called by him *T. inquilinus*, as a member of the genus Tintinnus, but distinct from the one with a closed aboral end so clearly described by Fauré-Fremiet (1908b) and very definitely included in the original description of Müller (1777, pl. 9, fig. 2) and in Ehrenberg's (1838, pl. 30, fig. II, 1–3) later account.

Up to the time of Apstein's (1915) designation of the type of Tintinnus no type had been designated, but Fauré-Fremiet's removal of *T. inquilinus* to Tintinnidium was clearly based on a wide knowledge of the morphology of Tintinnidium and of Tintinnus, and on a critical consideration of the older literature, though not of the question of type species.

As will be seen upon reading our discussion of the problem raised by the nomenclatural history of *Tintinnus inquilinus* (Müller) Schrank= *Tintinnidium inquilinum* (Müller) Fauré-Fremiet (see K. and C., 1929, pp. 11–15), that a review of the literature shows that two species had been included in the past in *Tintinnus inquilinus*, both with a hyaline lorica, one with a closed aboral end, removed by Fauré-Fremiet (1908b) to Tintinnidium as *Tdm. inquilinum*, and one with an open aboral end, described under the name *Tintinnus inquilinus* (O.F.M.) by Daday (1887a, pl. 18, fig. 2) and later named *T. apertus* by us (1929, fig. 648).

The application of the Code of Nomenclature to this problem leaves only one solution available. It is perfectly clear that O. F. Müller (1777) was dealing with a neritic species with a closed aboral end. This species was included by Schrank (1803) when he founded his genus Tintinnus, and is the only one of the three included by him which belongs to the Tintinnoinea. This species, *Tintinnus inquilinus*, was selected by Apstein (1915) as the type of Tintinnus, although Fauré-Fremiet (1908b) had transferred it to the genus Tintinnidium, and this selection has a legal claim for continuance.

Jörgensen's (1924) limitation of the genus Tintinnus to loricæ with an open aboral end has a sound morphological basis, but Apstein's (1915) selection of *T. inquilinus* as its type conflicts with this limitation and compels a new generic name for the group of species selected by Jörgensen as Tintinnus.

To this group (excluding Daturella) we give the new generic name Eutintinnus, with *Eutintinnus birictus* K. and C. (1929, fig. 634) as the type species, and limit the old genus Tintinnus to a group of species

with homogeneous walls and closed aboral ends, including the species *inquilinus* as type, and certain related species transferred from Bursaopsis. Eutintinnus is applied to the much larger and better known pelagic group of species with loricæ with an open aboral end. This procedure has the following advantages: The etymology of the name relates the genus Eutintinnus to the family Tintinnidæ and the new genus is restricted to a group of congruous species. The genus Tintinnidium, to which Fauré-Fremiet (1908b) transferred *Tintinnus inquilinus*, has a soft lorica with included and adherent particles, whereas the species *inquilinus* has a transparent, rigid lorica of homogeneous texture, of the type found generally in the Tintinnidæ. The transfer back to the Tintinnidæ of this species *inquilinus* is sound from the standpoint of classification. The designation by us of the lorica with an open aboral end as a new species *T. apertus* (1929, fig. 648), described by Daday (1887b) as *T. inquilinus* O. F. M., also serves to clarify the long existing confusion.

In Eutintinnus a variety of structural modifications of a basic slender, conical, or tubular lorica have been evolved among the 29 known species. Certain progressive tendencies appear among them upon grouping the species according to structure in six series. These tendencies may be summed up as follows: There is, in the first place, in each of the six series of species differentiated from one another by one or more structural characters, an increase in size, or a progressive increase in length. The species in each of the structurally differentiated series can be arranged in such a sequence of increasing length, accompanied by a general increase in diameter, though not as a rule proportionally, and not always uninterruptedly. This absence of proportionality is involved in the varying proportions which appear in the several species. There is no evidence of a correlation of small-sized species with higher temperatures, or of large-sized ones with colder waters, though there is some evidence of such correlation within the individuals of given species.

In the second place, there emerge in the genus a group of structural characters which, singly, or in combination, in all or in a part of the species, characterize the several series into which the species of the genus may be assorted. Such a character, or characters, are not developed to an equal degree in all members of the series which are thus characterized. The smallest species in the series generally exhibits the character in a lower degree of development than the larger ones. Thus, the smallest species in each series is structurally, at least, if not historically, the most primitive.

Lastly, these smallest and presumably most primitive species of the six series, namely, *pacificus*, *stramentus*, *macilentus*, *perminutus*, *tubus*, and *turris*, are more nearly alike than are the terminal, or largest, species of the series, namely, *lusus-undæ*, *attenuatus*, *birictus*, *latus*, *angustatus*, and *mirabilis*.

The structural characters which are utilized in differentiating subgenera and series of species of the genus are (1) the circumoral rim in the subgenus Eutintinnus; (2) the suboral funnel in the subgenus Eutintinnus, including the *pacificus*, *stramentus*, *macilentus*, and *perminutus* series; (3) the very tapering shaft well developed only in the *stramentus* series, but suggested also in the smallest species of the *macilentus* and *turris* series; (4) the bulge in or near middle of shaft in the *perminutus* series, seen elsewhere only in *mirabilis* of the toothed *turris* series; (5) the well developed aboral funnel in the *macilentus* and *perminutus* series only; (6) the contracted aboral region found only in the *tubus* series constituting the subgenus Ceratotintinnus; and (7) the circumoral ring of teeth in the *turris* series constituting the subgenus Odontotintinnus. Two other structural features emerge in a few species only, neither of which affords a basis for a series, namely the abrupt aboral constriction in *colligatus* only, without parallel in the family Tintinnidæ, and the characteristic substance of the wall of the lorica found only in *tubiformis* of the *macilentus* series, and *rugosus* of the *turris* series. In both of these the wall is somewhat thickened generally, has a sooty brown tinge, and is covered externally with numerous short, uniform, longitudinal wrinkles. Possibly this group should be separated from Eutintinnus as a distinct genus.

There is a range of variation within the species, usually exhibited by a relatively small number of individuals, which suggests degrees in the development or expression of these specific characters, such as the median bulge and the suboral and aboral flares. These may be mere consequences of the varying amounts of lorica substance or varying relative rates of lorica formation in the several regions, and may result from the amount and nature of the food during the period of accumulation of lorica substance in the cytoplasm and the temperature attending its extrusion and shaping into the lorica.

Contains 29 species, of which 19 are recorded in Expedition collections. Of these 29 species, 17 were new (K. and C., 1929), and of these, 13 were present in Expedition material. One other, *E. apertus* (K. and C.), was assigned a new name. Subdivided into 6 series belonging to 3 new quite distinct subgenera, Eutintinnus, Ceratotintinnus, and Odontotintinnus.

EUTINTINNUS subgen. nov.

Eutintinnus with an entire circumoral rim; marine; principally, if not wholly, pelagic in warm temperate and tropical seas. Type species *Eutintinnus birictus* K. and C., (1929, p. 332, fig. 634) from Sta. 4574 in California Current. Includes 21 species, in 4 series as follows: the *pacificus* series, including *pacificus, tubulosus, pinguis, tenuis,* and *lusus-undæ;* the *stramentus* series, including *stramentus, colligatus,* and *attenuatus;* the *macilentus* series, including *macilentus, maculatus, tubiformis, fraknóii, elongatus,* and *birictus;* and the *perminutus* series, including *perminutus, elegans, turgescens, procurrerens, medius, brandti,* and *latus.*

CERATOTINTINNUS subgen. nov.

Eutintinnus with aboral region contracted to a narrowed section; aboral opening rimless, not over 0.5 of oral opening in diameter; in marine and brackish waters. Type species *Eutintinnus angustatus* (Daday, 1887b, pl. 18, fig. 15) from Bay of Naples. Contains the *tubus* series, including *tubus, apertus,* and *angustatus.*

ODONTOTINTINNUS subgen. nov.

Eutintinnus with circumoral row of equal, equidistant, slender, vertical, triangular teeth; no marked suboral or aboral flare; shaft a narrow, inverted, truncated cone or cylinder; wall hyaline, in one species wrinkled; marine, from temperate and cooler coastal waters. Type species *Eutintinnus turris* (K. and C., 1929, fig. 642) from Nome Bay, Alaska. Contains the *turris* series, including *turris, pectinis, mirabilis, rugosus,* and *rectus.*

EUTINTINNUS APERTUS (Kofoid and Campbell)

Plate 31, fig. 4

T. inquilinus, Hofker, 1931b, p. 386, figs. 82–83.

Lorica tall funnel-shaped, an inverted, truncated cone, contracted in aboral 0.15 as narrower section below rounded shoulder formed by intermediate cone; 2.3–2.6 (2.5) o.d. Oral margin with narrow horizontal projecting rim above slight flare in shaft below. Shaft with anterior 0.78 of lorica forming an inverted, truncated cone of 6–9°, with diameter decreasing evenly aborally, without bulge, to a lower

diameter of 0.60–0.85 (0.70) o.d., contracting abruptly below this level, a low, convex, inverted, truncated intermediate cone of 37°, with lower diameter 0.60–0.70 (0.67) o.d., and 0.06 t.l. Aboral section projecting below this cone as a narrower, concave truncated cone, 0.16–0.30 t.l. and 0.33–0.60 (0.51) o.d. in diameter anteriorly, with straight or slightly concave sides forming an inverted, truncated cone of not over 5°. Aboral aperture rimless, not everted, 0.30–0.56 (0.49) o.d. in diameter. Wall uniform in thickness. Animal with 4 oval macronuclei, noted by Entz, Jr. (1909b, pl. 13, fig. 11), in our material 5 by 10 μ, equidistant, arranged in a longitudinal spiral; and 4 globular micronuclei, each 1.2 μ in diameter. Hofker (1931b) finds only 2 micronuclei. There are 18 intercalary tentaculoids 0.6 length of membranelles in length, with globular distal organs; 18 longitudinal myonemes, and 18 membranelles (Brandt, 1907, p. 22). Peduncle 0.4 length of animal, attached at one side of lorica (Daday, 1887b, pp. 529–531). Cases of symbiosis between certain diatoms (Chætoceras) to which the tintinnids are anchored are noted by Ehrenberg (1834), Famintzin (1889), Fauré-Fremiet (1908a), Schweyer (1909), Pavillard (1916), Jörgensen (1924), and Hofker (1931b). We have found this relationship abundantly in our own material of this species. This condition obtains also in certain other tintinnids, as in *lususundæ* in our material; also noted by Fol (1884, pl. 5, fig. 15) in *Rhabdonella elegans*.

Eight loricæ: L., total, 70–102 (90.0). D., oral, 29–36 (33.3); diameter at shoulder, 20–33 (24.8); aboral, 14–18 (16.6) μ.

At 8 stations, viz., at 3, 3, and 2, respectively, in Peruvian Current, Panamic Area, and Drift; at 67–81 (73.5)°; 8 loricæ.

Eutintinnus birictus (Kofoid and Campbell)

Plate 31, fig. 9

Lorica exceedingly large, very long, slender, tubular, with flaring, rather wide, subequal, funnel-like expansion at each end; 6.3–10.6 (7.9) o.d. Oral margin feebly differentiated as an everted, narrow, projecting horizontal rim with a slight peripheral thickening. Suboral flare a long, slightly flaring funnel, an inverted, truncated cone of 11–22°, 0.45–1.40 o.d. in length. Shaft below this contracting evenly to least diameter, at 0.74–0.83 t.l. from oral end, 0.4–0.6 o.d. in diameter, a very long, inverted cone of 1.5–3°. Aboral region a truncated cone of 20–25°, with slightly concave sides; 0.2–0.6 o.d. in length. Aboral diameter 0.60–0.89 o.d. Aboral rim not thickened. Wall with a few instances

of inclusion of coccoliths (?), nearly uniform in thickness, slightly thicker in oral rim.

Ten loricæ: L., total, 377–650 (502.0). D., oral, 58–67 (63.4); midway, 44–58 (51.3); aboral, 32–42 (38.6) μ.

At 20 stations, viz., at 2, 1, 3, and 14, respectively, in California and Peruvian currents, Easter Island Eddy, and Drift; at 68–81 (72.7)°; 42 loricæ.

Eutintinnus brandti (Kofoid and Campbell)

Plate 32, fig. 9

Lorica elongated, truncated cone of 4–5°, with well developed premedian bulge and widely flaring, subequal oral and aboral regions; 3.67–5.63 (5.05) o.d. Oral margin with narrow, projecting, thickened oblique rim, abruptly merging with suboral flare which is an inverted, truncated, concave cone of 20–45°, with concavity increasing abruptly orally; 0.25–0.90 o.d. in length. Nuchal diameter 0.7–0.8 o.d. Shaft as a whole a bulging, truncated cone of 2–3°. Upper shaft increasing evenly and regularly in diameter as truncated cone of 5–8° to level of premedian bulge, 0.44–0.61 (0.53) o.d. in diameter, contracting concavely in posterior 0.55–0.65 t.l. as an inverted, truncated, concave cone of 7–9°, decreasing evenly to least diameter (0.35–0.55 o.d.) at 0.1–0.3 t.l. from aboral end. Aboral funnel a truncated, very concave cone of 13–24°, 1–2 o.d. in length. Aboral aperture 0.64–0.93 (0.73) o.d. in diameter. Aboral margin usually rimless, but sometimes with slight thickening or terminal projection of wall. Wall thickened in oral funnel; elsewhere uniform.

Nine loricæ: L., total, 205–339 (289.0). D., oral, 53–63 (57.4); least diameter, 27–34 (30.7); aboral, 32–52 (42.6) μ.

At 15 stations, viz., at 3, 2, 1, 2, and 7, respectively, in California, Mexican and Peruvian currents, Easter Island Eddy, and Drift; at 68–81 (76)°; 23 loricæ.

Eutintinnus colligatus (Kofoid and Campbell)

Plate 31, fig. 11

Lorica very elongated, slender, trumpet-shaped, as a whole an inverted, truncated cone of 6–9°; 4.8–5.8 (5.3) o.d. Oral margin with narrow, projecting, horizontal or oblique, often abruptly everted rim. Suboral funnel flaring rather widely, an inverted, truncated, evenly concave cone of 20–35°; 0.6–1.2 o.d. in length, merging abruptly with

shaft. Nuchal diameter 0.50–0.69 o.d. Shaft long, tapering, inverted, truncated cone of 3–5°, tapering from throat evenly and regularly without local bulge, or in some loricæ with a very slight median or postmedian convexity, with diameter midway 0.48–0.63 (0.53) o.d.; contracting abruptly immediately above aboral funnel, a very low, inverted, truncated, intermediate cone of 25–35°, longer than wide; 0.12–0.14 o.d. in diameter at posterior end. Aboral funnel below intermediate cone, truncated cone of 45–70°, with concave sides, not over 0.5 aboral diameter in length. Aboral margin rimless. Aboral aperture 0.33–0.37 (0.35) o.d. in diameter. Wall thicker in suboral funnel, uniformly thinner in shaft, and slightly thickening in aboral funnel at widest level. Animal with 4 oval macronuclei, each 5 by 7 μ, filling 0.5 t.l. in upper part of lorica.

Twenty-three loricæ: L., total, 254–295 (270.9). D., oral, 49–54 (51.1); midway, 25–30 (27.4); aboral, 15–20 (18.0) μ.

At 15 stations, viz., at 6 and 9, respectively, in Panamic Area and Drift; at 72–81 (76.9)°; 95 loricæ.

Eutintinnus elongatus (Jörgensen)

Plate 31, fig. 7

Lorica elongated, slender, trumpet-shaped, with widely flaring oral and aboral regions; 4.45–6.83 (5.83) o.d. Oral margin with very narrow, scarcely projecting horizontal rim. Suboral funnel, a very widely flaring, slightly concave, inverted, truncated cone of 15–32°, but usually 26–32°, in one lorica 55°; 0.15–1.20 o.d. in length. Nuchal diameter 0.47–0.60 o.d. Shaft very long and tapering, an inverted, truncated cone of 3–7°, with straight sides; its diameter midway 0.45–0.57 (0.52) o.d. Aboral flare, or funnel, a truncated cone of 25–57°, with somewhat concave sides, with diameter at neck 0.4–0.5, aboral diameter 0.48–0.55 (0.52), and length 0.16–0.40 o.d. No aboral rim. Wall 0.013 o.d. in thickness. Animal with 4 oval macronuclei, each 7 by 13 μ, and a similar number of adjacent micronuclei, filling aboral 0.6 of lorica. Binary fission, observed in one animal, of the usual type, with lateral, newly forming peristome and with nuclei crowded near it, but without evidence of fusion, as suggested by Laackmann (1906) and Entz, Jr. (1909b). An oval, clear-walled cyst, 30 by 57 μ, was seen in one lorica (Figure 921) just above middle, with a thin, regular wall and an irregular, probably contracted, granular cytoplasm, enclosing 4 macronuclei of irregular outline, and 4 oval micronuclei, each 3 by 4 μ, possibly enlarged prior to fission.

One hundred loricæ: L., total, 204–394 (306.9). D., oral, 46–64 (52.6); midway, 24–34 (27.4); aboral, 24–34 (27.8) μ.

At 82 stations, viz., at 5, 8, 16, 1, 11, 2, 8, and 31, respectively, in California, Mexican, Peruvian, and North Equatorial currents, Panamic Area, Galapagos and Easter Island eddies, and Drift; at 66–84 (74.4)°; 458 loricæ.

Eutintinnus fraknóii (Daday)

Plate 31, fig. 10

Tintinnus lusus-undæ, partim, Jörgensen, 1899, pp. 4, 8, 9, 42; 1900, p. 64; 1912, pp. 1, 2, 16 (see also *E. lusus-undæ*).
Tintinnus fraknói, Gräf, 1909, p. 187, fig. (25)a.
Tintinnus frakenóii, Hofker, 1931b, pp. 385–386, fig. 81.
Favella fraknóii, Hofker, 1931b, pp. 380–381.

Lorica very large, elongated, slender conical, concave tubular, with slightly flaring funnel at each end; 5.16–6.56 (5.81) o.d. Oral margin a thin narrow, projecting, horizontal or oblique, slightly thickened, and very distinct rim. Suboral funnel flaring 12–25°, scarcely differentiated from shaft except by slightly localized increase in flare, concave outwardly or nearly straight; 0.10–0.13 total length. Nuchal diameter 0.8–0.9 o.d. Shaft 0.8–0.9 total length, circular in cross section, an evenly tapering tube or segment of a slightly concave inverted cone of 3–5°, with diameter midway 0.52–0.66 (0.60) o.d. Aboral collar a concave-sided, inverted funnel in shape of a truncated cone of 32–55°, 0.03–0.09 total length. Aboral aperture 0.62–0.73 (0.68) o.d. in diameter. Aboral margin without thickened rim. Wall without prismatic structure in our material, though Brandt (1907, p. 423) speaks of rather large polygonal prisms sometimes found in *fraknóii;* uniformly thin-walled, 0.02 o.d. in thickness, with minute scattered coccoliths (?) included, also found by Biedermann (1893). Animal with 4 oval macronuclei, each 10 by 20 μ, arranged in a leiotropic spiral, and associated with each macronucleus a small globular micronucleus 1.5 μ in diameter. There are 18 or 20 membranelles 25 μ in length surrounding the deeply sunken frontal field 30 μ in diameter. Animal pyriform, surmounting a narrow peduncle attached aborally to side of lorica. There are 18 or 20 long stalked tentaculoids and as many parallel rows of long cilia. Myonemes following ciliary lines are present. Parasites, presumably Blastodinium, are reported by Chatton (1919). This species, like *apertus*, is sometimes found with one to four frustules of Chætoceras (Schweyer, 1909) attached to upper part of lorica.

Fourteen loricæ: L., total, 310–420 (364.8). D., oral, 60–70 (62.8); midway, 35–43 (38.0); aboral, 39–49 (42.8) μ.

At 24 stations, viz., 1, 1, 5, 1, 1, 1, and 14, respectively, in California, Mexican, Peruvian, South and North Equatorial currents, Panamic Area, and Drift; at 67–83 (75.1)°; 40 loricæ.

Eutintinnus lusus-undæ (Entz, Sr.)

Plate 32, fig. 3

Tintinnus lusus-undæ, Jörgensen, 1899, pp. 4, 8, 9, 42; 1900, p. 64; 1912, pp. 1, 2, 16 (see also *E. fraknóii*).

Lorica long, subcylindrical, stouter than *tenuis*, short funnel-shaped anteriorly; 3.6–4.9 (4.2) o.d. Oral margin abruptly flared, not thickened, projecting as a low, horizontal rim. Suboral funnel flaring as an inverted, truncated, outwardly concave cone of 17–32°, 0.2–0.3 t.l. Nuchal diameter 0.6–0.7 o.d. Shaft a subcylindrical tapering tube, an inverted, truncated cone of 1–3°, without local inflations or contractions, decreasing evenly from throat to aboral end. Aboral end squarely truncated, without rim or flare. Aboral diameter 0.54–0.67 (0.61) o.d. Wall homogeneous, or with fine prisms (Brandt, pl. 65, fig. 11a), rarely with faintly streaked areolate walls, uniform in thickness in shaft, and slightly thicker in collar. Animal with 4 macronuclei and 18 membranelles (Brandt, 1907, p. 21). We have seen an individual of *lusus-undæ* from off La Jolla, California with three empty loricæ of a small species of Acanthostomella in the cytoplasm. Symbiosis with Chætoceras occurs in our material, the frustules being attached to side of lorica, as in *apertus*.

Ten loricæ: L., total, 177–238 (210.4). D., oral, 46–50 (47.8); aboral, 27–32 (29.4) μ.

At 16 stations, viz., at 4, 2, 3, and 7, respectively, in California, and Peruvian currents, Panamic Area, and Drift; at 68–83 (74.3)°; 32 loricæ.

Eutintinnus macilentus (Jörgensen)

Plate 32, fig. 1

Lorica a short, inverted, truncated, very concave cone of 6–9°; 3.6–4.5 (4.2) o.d. Oral margin circular, with thin, projecting, almost horizontal rim. Suboral funnel, an outwardly concave, inverted cone of 20–29°, 0.9–1.2 o.d. in length, merging imperceptibly into shaft. Nuchal diameter 0.8–0.9 o.d. Shaft an inverted, truncated cone of

3–5°, without local bulge or contraction, very slightly concave throughout in contour, 0.51–0.61 (0.54) o.d. in diameter midway of total length, and 0.4–0.5 at level of least diameter. Aboral funnel a slightly concave, truncated cone of 26–46°, with aboral diameter of 0.58–0.73 (0.66) o.d. Aboral margin rimless. Wall uniform in thickness.

Nineteen loricæ: L., total, 136–190 (165.1). D., oral, 33–43 (39.2); midway, 18–25 (22.5); aboral, 21–28 (26.0) μ. Brandt's lorica (pl. 65, fig. 16): 327, 63, 40, and 32 μ. The magnification of figure is stated to be 225; in case it were 550, a magnification frequently used by Brandt (1906), its dimensions would conform to ours.

At 14 stations, viz., at 2, 1, and 11, respectively, in Peruvian Current, Easter Island Eddy, and Drift; at 68–81 (74.2)°; 29 loricæ.

Eutintinnus medius (Kofoid and Campbell)

Plate 31, fig. 8

Lorica moderately stout, inverted, truncated cone of 3–5° as a whole, with minimum amount of median bulge; 3.69–4.77 (4.38) o.d. Oral margin with very slight but definitely projecting, somewhat thickened rim. Suboral funnel truncated, concave cone of 25–40°, merged aborally with shaft; 0.25–1.00 o.d. in length. Nuchal diameter 0.75–0.90 o.d. Shaft as a whole a bulging, truncated, inverted cone of 2–3°, its diameter slightly greater midway of total length, 0.65–0.71 (0.68) o.d., than at either end. Aboral funnel a truncated, inverted, outwardly concave cone of 25–42°, 0.2–0.8 o.d. in length, rather more abruptly set off from shaft than is the oral flare. Aboral diameter 0.60–0.71 (0.65) o.d. No aboral rim. Wall uniformly thin, except for very slight thickening in rim. One deformed lorica from Sta. 4611, had a row of 22 frustules of diatom Grammatophora vertically arranged a little distance below oral rim.

Ten loricæ: L., total, 192–258 (235.9). D., oral, 51–55 (52.9); midway, 33–38 (36.3); aboral, 32–37 (34.7) μ.

Differs from *lusus-undæ* in that it is longer (195–254 μ, instead of 177–238 μ), has a flaring aboral funnel in place of simple, truncated aboral end, and shaft usually, though not always, bulging in middle. Differs from *elegans* (147–190 μ) and *brandti* (205–339 μ) in being intermediate (192–258 μ) in length, and in having less bulge.

At 11 stations, viz., at 5, 1, 2, 2, and 1, respectively, in California, Mexican and Peruvian currents, Easter Island Eddy, and Drift; at 66–83 (72.7)°; 48 loricæ.

Eutintinnus pacificus (Kofoid and Campbell)

Plate 31, figs. 2, 3

Lorica very small, short, tumbler-shaped, an inverted truncated cone; 2.30–3.37 (2.33) o.d. Oral rim slightly but abruptly projecting. Shaft in anterior 0.5–0.6 an inverted truncated cone of 4–9°, with slope changing below rather abruptly to an aboral cone of 7–11°. Lorica as a whole an inverted truncated cone of 6–9°. Aboral end 0.65 o.d. in diameter, without rim. In one of our loricæ contour crenulated by slight, short, local, subuniform undulations of wall. Wall 0.06 o.d. in thickness. Animal with 4 oval macronuclei, each 4 by 5 μ. In one individual there were 11 membranelles on one side.

Three loricæ: L., total, 67–71 (69.5). D., oral, 29–30 (29.2); aboral, 19–20 (19.2) μ.

At 3 stations, in Drift; at 75–77°; 4 loricæ.

Eutintinnus perminutus (Kofoid and Campbell)

Plate 31, fig. 1

Lorica as a whole a relatively short, inverted, truncated cone of 3–6°, with slight and gradually differentiated median bulge of shaft, and abrupt, narrow oral and aboral flares; 4.25–5.40 (4.70) o.d. Oral margin with narrow, projecting, horizontal, thickened rim, merging with suboral funnel flaring 25–40°, with outwardly concave sides, 0.5–0.6 o.d. in length, merging gradually into shaft. Nuchal diameter 0.60–0.75 o.d. Shaft with a median bulge, best seen in end view; as a whole forming a truncated cone of 7–10°, inflated regularly and evenly from throat, with a little convexity, to middle of shaft, reaching a diameter of 0.70–0.81 (0.76) o.d., a truncated cone of not over 3–8°. Posterior 0.5 of shaft an inverted, truncated convex cone of 8–15°, contracting from middle of shaft evenly and regularly with a slight distal concavity. Aboral funnel an outwardly concave, truncated cone of 15–32°, with diameter at upper level of greatest constriction 0.35–0.50 o.d., and at aboral orifice of 0.54–0.70 (0.65) o.d., and length of 0.25–0.40 o.d. Aboral margin without rim. Wall uniform in thickness.

Eleven loricæ: L., total, 145–183 (155.0). D., oral, 32–34 (33.1); bulge, 24–27 (25.3); aboral, 20–24 (21.2) μ.

At 12 stations, viz., at 1, 2, 1, and 8, respectively, in California, Mexican and Peruvian currents, and Drift adjacent to the latter current; at 69–78 (73)°; 18 loricæ.

Eutintinnus pinguis (Kofoid and Campbell)

Plate 31, fig. 6

Lorica tall, tumbler-shaped, inverted, truncated cone of 7.5–12°, with slight oral rim, and slight median bulge; 2.60–3.08 (3.09) o.d. Oral rim minute, horizontally projecting ledge with taper of not over 10° for 0.2–0.5 o.d. below it in shaft, below oral rim. Shaft with median bulge, due in part to localized transition in slope; continuing evenly and regularly from suboral taper to transition in slope midway of lorica. Upper bowl a cylinder or inverted, truncated cone of 3–6°, with diameter of base 0.8–0.9 (0.85) o.d. Lower bowl contracting evenly and regularly as a truncated, inverted cone of 7–11°, continuing in some loricæ to aboral end, but in others changing to a cylinder in the posterior 0.16–0.20 t.l. Aboral end squarely truncated, 0.53–0.73 (0.59) o.d. in diameter, without a rim. Wall uniform in thickness, except for slight thickening below oral margin.

Five loricæ: L., total, 114–161 (134.3). D., oral, 41–47 (43.7); midway, 34–39 (36.5); aboral, 24–30 (27.4) μ.

Jörgensen's (1924, p. 12) inclusion of *tubulosus* in *apertus* may be accompanied also by an inclusion of some loricæ of this species. His figure 7a answers somewhat to ours of *pinguis*, except that it is contracted aborally much more than any of ours, to less than 0.5 o.d. in his and to 0.53–0.73 (0.59) in ours.

At 7 stations, viz., at 2, 4, and 1, respectively, in California, Mexican and South Equatorial currents; at 76–84 (81)°; 65 loricæ.

Eutintinnus procurrerens (Kofoid and Campbell)

Plate 31, fig. 5

Lorica very widely bulging, as a whole an inverted, truncated cone of 3–6°; 3.20–4.45 (3.89) o.d. Oral margin with a narrow, horizontal, projecting rim. Suboral funnel inverted, truncated, concave cone of 16–37°; 0.35–0.85 o.d. in length, merging gradually into shaft. Nuchal diameter 0.6–0.7 o.d. Shaft as a whole a truncated cone of 8–10° with a very marked, slightly postmedian, rarely median, expansion. Upper shaft increasing evenly in diameter in anterior 0.5 from throat to postmedian level of greatest diameter, 0.67–0.90 (0.73) o.d., a concave, truncated cone of 2–7°. Posterior 0.5 of shaft proper an inverted, concave, truncated cone of 8–12°, with diameter above aboral funnel 0.44–0.55 o.d. Aboral funnel very well differentiated, a concave,

truncated cone of 20–35°, 0.25–0.40 o.d. in length. Aboral aperture rimless, 0.53–0.72 (0.64) o.d. in diameter. Wall uniform in thickness.

Twenty-five loricæ: L., total, 138–206 (147.7). D., oral, 41–48 (44.7); midway, 31–37 (32.6); aboral, 24–33 (28.4)μ.

At 22 stations, viz., at 1, 1, 9, and 11, respectively, in Mexican Current, Galapagos and Easter Island eddies, and adjacent Drift; at 72–83 (76.1)°; 69 loricæ.

Eutintinnus rugosus (Kofoid and Campbell)

Plate 32, fig. 5

Lorica a simple subcylindrical tube in anterior 0.5 and a cone of 2.5° posteriorly, with a very slight terminal aboral flare; 4.6 o.d. Suboral region very slightly everted and locally thickened into a rim. Oral margin with erect, deeply serrate row of 44 sharply pointed, triangular teeth, 0.11 o.d. in length, and 0.03 across base, including rounded bodies of irregular dimensions which are probably coccoliths; rising from inner face of slightly thickened suboral margin. Oral opening, at base of serrated collar, 60μ in diameter, the greatest diameter of the lorica. Immediately below oral margin a very slight constriction. Shaft with frequent minor irregularities of outer contour, rather evenly distributed. Least diameter 0.85 o.d., just above slightly flaring aboral end. Aboral region concave outwardly, a truncated cone of 25°, 0.12 o.d. in length. Aboral end 0.92 o.d. in diameter, evenly truncated and rimless. Lorica of a dark, smoky brown color, with rough surface, irregular in contour, and bearing many irregularly arranged, longitudinal, very short wrinkles or rugæ. Wall with maximum thickness near oral margin, and minimum at aboral end.

L., total, 275. D., oral, 60; midway, 58; aboral, 55μ.

Wailes (1925, pl. 2, figs. 22, 23) figures two loricæ of *rectus* stated to be x 200 in explanation of figures. At this magnification the longer of these two loricæ is 305μ. On page 7 of his text he states that the length is 176–255μ. It may be, therefore, that the magnification should read x 300 instead of x 200; if this is correct his longest lorica (fig. 23) is 200μ. Our *Conspectus* (1929, fig. 645) has a copy of Wailes's figure at x 200, which is therefore too large for the stated dimensions. If this solution is incorrect, *rectus* is somewhat longer, instead of shorter, than *rugosus*.

At Sta. 4675; at 68°; 1 lorica.

Eutintinnus stramentus (Kofoid and Campbell)

Plate 32, fig. 6

Lorica very slender, hyaline, uniformly tapering, truncated cone; 4.4–6.0 (5.6) o.d. Oral margin with slightly thickened, very narrow, horizontally projecting rim. Suboral funnel not differentiated, or represented by flare of not over 15–20° for up to 0.4 o.d. below oral rim. Shaft below flare tapering up to 4–8°, with only very slight irregularities. Aboral end rimless, squarely truncated, not everted, with diameter of 0.35–0.55 (0.41) o.d. Wall uniform in thickness.

Ten loricæ: L., total, 105–165 (146.2). D., oral, 23–28 (26.0); midway, 13–18 (15.4); aboral, 8–13 (10.9) μ.

At 11 stations, viz., at 2, 2, 4, 1, and 2, respectively, in California and Mexican currents, Panamic Area, Easter Island Eddy, and Drift; at 72–84 (77.6)°; 20 loricæ.

Eutintinnus tenuis (Kofoid and Campbell)

Plate 32, fig. 2

Lorica relatively narrow and rather long, anteriorly a funnel-shaped cone, subcylindrical posteriorly without aboral differentiation; 4.3–6.1 (4.8) o.d. Oral margin with narrow, thickened, projecting, horizontal rim. Suboral funnel flaring, either tall, concave funnel in form of inverted, truncated cone of 9–17°, or shorter, wider one of 28–46°, both merging imperceptibly into shaft; 0.12–0.19 t.l. Nuchal diameter 0.70–0.85 o.d. Shaft tapering evenly and regularly from throat to aboral end as an inverted, truncated cone of 2–6°, without local swellings or transitions in slope. Aboral end squarely truncated, without aboral flare or rim, its diameter 0.52–0.65 (0.59) o.d. Wall thickest in suboral funnel, uniformly thinner elsewhere. One lorica, from Sta. 4580, had a cuirass of four elongated frustules of an unidentified diatom of the genus Isthmia, resembling *I. enervis*, adherent around lorica in a vertical row just below oral funnel.

One hundred and six loricæ: L., total, 179–237 (193.7). D., oral, 38–45 (42.2); aboral, 24–27 (25.0) μ.

At 59 stations, viz., at 5, 6, 9, 1, 1, 11, 1, 3, and 22, respectively, in California, Mexican, Peruvian, South Equatorial and Equatorial Counter currents, Panamic Area, Easter Island and Galapagos eddies, and Drift; at 66–84 (75.4)°; 244 loricæ.

Eutintinnus tubiformis (Kofoid and Campbell)

Plate 32, fig. 7

Lorica relatively very stout, subcylindrical, flaring outwardly abruptly and subequally at both ends; 4.4–6.2 (5.2) o.d. Oral margin a rounded, relatively thick lip, merging into collar. Suboral funnel abruptly flaring, a truncated cone of 63–90°, 0.2–0.5 o.d. in length, with thickened wall. Lorica contracting below oral margin to 0.95 o.d., tapering gently to a mid-diameter of 0.8 o.d., and then to least diameter, 0.7 o.d., at 0.98 t.l. from oral margin, flaring aborally in a short aboral funnel of 75–82°, either abruptly or gradually, to everted, rounded aboral margin. Aboral diameter 0.9 o.d. Lorica an inverted, truncated cone of 2–3°, without rims. Wall of dark brownish tinge, with rough surface covered with fine, irregular, evenly distributed, longitudinal rugæ, or wrinkles; thicker in oral and aboral rims, and thinner elsewhere.

Eleven loricæ: L., total, 323–414 (358.3). D., oral, 67–73 (68.8); midway, 58–66 (61.0); aboral, 52–62 (54.5) μ.

At 9 stations, viz., at 1, 1 and 7, respectively, in Mexican and South Equatorial currents, and Drift; at 75–84 (79.1)°; 18 loricæ.

Eutintinnus tubulosus (Ostenfeld)

Plate 32, fig. 8

Tintinnus lusus-undæ, Hofker, 1922, p. 169, fig. 75; 1931b, p. 387, fig. 84 (a), (b).

Lorica short, hyaline, open tumbler-shaped, an inverted, truncated cone; 2.5–3.4 (3.09) o.d. Oral rim projecting horizontally abruptly and very slightly. Shaft short, inverted, truncated cone of 4–10°, with regularly contracting sides. Aboral end without rim, 0.60–0.70 (0.67) o.d. in diameter. Wall very thin except for slight thickening at oral margin. Animal filling 0.6 of lorica, with 4 oval macronuclei, each 5 by 6 μ.

Six loricæ: L., total, 85–103 (94.3). D., oral, 29–34 (31.0); aboral, 20–23 (21.0) μ.

At 12 stations, viz., at 1, 4, 2, and 5, respectively, in Mexican and Peruvian currents, Galapagos Eddy, and Drift; at 66–84 (74.6)°; 20 loricæ.

Eutintinnus turgescens (Kofoid and Campbell)

Plate 32, fig. 4

Lorica as a whole a short tube, a truncated, inverted, funnel-shaped cone of 6–9°; 3.2–4.4 (3.8) o.d. Oral margin with horizontal, thickened, projecting rim, merging into suboral funnel; an inverted, truncated, concave cone of 20–35° merging quickly into shaft; 0.1–0.3 t.l. Nuchal diameter 0.60–0.79 o.d. Shaft as a whole a tapering tube, a cone of 5–8°, with a slight median or postmedian bulge, 0.7–0.9 t.l., with greatest diameter (0.64–0.75 [0.66] o.d.) within middle 0.25 of length, decreasing below evenly to within short distance of squarely truncated, rimless aboral end, with opening 0.49–0.63 (0.57) o.d. Effect of median bulge on contour sometimes heightened not only by disappearance aborally of convexity, but by slight distal concavity which brings out slight aboral flare, which in more pronounced form is characteristic of the *macilentus* series. Feebly differentiated aboral funnel, 0.10–0.16 o.d. in length, a truncated cone of 12–22°. Aboral diameter 0.50–0.61 of oral. Wall uniform in thickness, except in slightly thickened rim. Animal with 4 globular macronuclei, 12μ in diameter, associated as two pairs, possibly in a division phase, and 4 globular micronuclei, 2.5μ in diameter.

Fifty-one loricæ: L., total, 147–193 (171.4). D., oral, 40–46 (43.9); midway, 27–31 (28.9); aboral, 23–28 (25.1)μ.

At 16 stations, viz., at 3, 2, 1, 1, 1, 2, 1, and 5, respectively, in California, Mexican, Peruvian and South Equatorial currents, Panamic Area, Galapagos and Easter Island eddies, and Drift; at 68–83 (74.8)°; 83 loricæ.

48. DATURELLA Kofoid and Campbell

Salpingellinæ with lorica elongated, truncated cone 3.58–8.60 o.d. in length; open at both ends, aboral diameter 0.2–0.9 o.d., with more suboral than aboral flare; shaft subcylindrical or slender inverted cone; with longitudinal, ribbon-like fins or homologous striæ; wall very soft, delicate, and flaccid, with prismatic structure; Tropical Atlantic, Mediterranean, and Pacific. Type species *Daturella datura* (Brandt) emended K. and C., from Guinea Current.

Emarginata and *datura* were described by Brandt (1906) in Tintinnus, both with soft loricæ with fins or striæ and strong prismatic structure. Our material, abundantly represented in our collections by a

variety of related forms, enables us to establish the content of this interesting genus. Jörgensen (1924) did not accept either *emarginata* or *datura* as valid species, erroneously suggesting that they were only deformed loricæ of questionable origin. The fins and striæ have all the features of definite morphological structure differing typically in different species in number, extent, and curvature. They are not deformations or artifacts resulting from mounting media or delicacy of wall. This delicacy is itself of generic value. The only questionable artifact, in our opinion, is the suboral constriction in *ora*, and we suspend judgment on even this.

Distinctly related to Eutintinnus in general form, but entirely different in texture of wall. Loricæ of both genera open at each end, and inverted conical in both, and both tend to flare at each end. The thickened wall of *Eutintinnus rugosus* and *tubiformis*, with numerous short longitudinal wrinkles, is suggestive of the thickened wall and longer striæ and fins of the *emarginata* series of Daturella. Soft wall with alveolar prismatic structure and long surface pleats clearly distinguish Daturella from all other genera of the Tintinnidæ. The development of fins is suggestive of Bursaopsis and Salpingella, but in the latter they are limited, with rare exceptions, to the aboral end, and the wall of Salpingella is rigid, hyaline, and without evident prismatic structure.

Contains 9 species, of which 5 are recorded in Expedition material. Of the 9 species 7 are new, 5 being present in Expedition material. Subdivided into series: the *angusta* series, including *angusta*, *recta*, and *emarginata;* and the *striata* series, including *striata*, *ora*, *datura*, *gaussi*, *stramonium*, and *magna*.

Daturella magna Kofoid and Campbell

Plate 30, fig. 3

Lorica very large, elongated trumpet-shaped; 5.2 o.d. Oral margin abruptly everted in recurved brim, 3.2 aboral diameters in diameter, and 0.03 o.d. in width. Suboral flare slightly developed, an inverted, truncated cone of 13°, 0.66 o.d. in length. Nuchal diameter 0.75 o.d. Shaft with premedian bulge, with greatest diameter (0.88 o.d.) at 2.0 o.d. below rim; upper shaft a subregular, truncated cone of 7°, and lower an inverted one of 15°, gradually changing into subcylindrical pedicel 0.5 o.d. in length and 0.3 in diameter. Aboral flare slight, a truncated cone of 8° equaling diameter of aboral opening, or 0.33 o.d. Sides of shaft irregular, due to fins and deformability. Fins 10 (11),

ribbon-like, arising at aboral margin and continuing for 0.67 t.l. subvertically, becoming slightly leiotropic above submedian bulge, increasing torsion suddenly to an angle of 60° from vertical at 0.5 o.d. below rim; not all extending to oral margin, some vanishing 0.25 o.d. below rim; decurrent above and below and 0.02 o.d. in thickness at base and 0.08 in height midway. Wall prismatic, thickened near central bulge about aboral margin; soft in texture and easily deformed. To its sticky surface many foreign objects, not coccoliths, adhere, but are not built into the wall.

L., total, 540. D., oral, 102; midway, 90; aboral, 31μ.

At Sta. 4571, in California Current; at 71°; 1 lorica.

Daturella ora Kofoid and Campbell

Plate 30, fig. 2

Lorica elongated, slightly subconical, as a whole an inverted, truncated cone of 10°; 4.0 o.d. Oral margin very abruptly and strongly everted and slightly recurved as a brim 0.2 o.d. in width, with overhang extending subhorizontally from shaft, 4.5 aboral diameters in diameter. Suboral or nuchal constriction below brim, very marked, 0.6 o.d., narrowest at 0.12 o.d. below brim. Suboral expansion abrupt, immediately below suboral constriction, widest (0.76 o.d.) at 0.35 o.d. below oral brim. Shaft with slight median bulge, widest (0.56 o.d.) at 1.8 o.d. below oral margin. Upper shaft a truncated cone of not over 5°, and the lower an inverted truncated cone of 7°; at 0.66 o.d. above aboral margin contracting to a feebly differentiated cylindrical pedicel 0.33 o.d. in diameter, with scarcely any aboral flare. Fins 4, subequidistant, subvertical, extending 0.85 t.l., widest midway of their length, decurrent at either end, 0.06 o.d. in height; a few short, subvertical lines, or creases, in wall of suboral constriction, possibly representing undeveloped fins. Wall prismatic and slightly thickened in suboral constriction.

L., total, 310. D., oral, 90; midway, 52; aboral, 22μ.

At Sta. 4724, in Drift; at 79°; 4 loricæ.

Daturella recta Kofoid and Campbell

Plate 28, fig. 1

Lorica elongated, tubular, slightly subconical as a whole; 3.7 o.d. Oral margin with a strong, horizontal, everted, recurved circumoral rim, 0.05 o.d. wide and 1.67 aboral diameters in diameter. Suboral

funnel concave, trumpet-shaped, 0.28 t.l., an inverted, truncated, cone of 18°. Shaft with faint median bulge, widest (0.75 o.d.) a little below middle, with diameter of 0.67 o.d. at narrowest part a little above bulge, and 0.6 o.d. aborally on feebly developed pedicel. Aboral margin angular and irregular (possibly broken). Fins 7, low, longitudinal, extending vertically full length of lorica from aboral margin to oral rim; widest midway, decurrent below rim, equidistant, with wall between flattened or slightly concave, shaft heptagonal in cross section. Wall thickened at middle of lorica, bulge being due in large part to increase of wall material; 0.05–0.07 o.d. in thickness.

L., total, 215. D., oral, 60; midway, 50; aboral, 45μ.

At Sta. 4717, in Galapagos Eddy; at 75°; 6 loricæ.

Daturella stramonium Kofoid and Campbell

Page 28, fig. 13

Lorica short, trumpet-shaped, with much suboral flare and median bulge; 4.30–5.90 (5.07) o.d. Oral margin with narrow, horizontal, everted but not recurved brim, 0.02 o.d. in width and 3.1–4.0 aboral diameters in diameter. Suboral flare convex, bowl-shaped, 0.33–0.50 o.d. in length, in the form of a deep soup plate, or a convex, truncated, inverted cone of 24–38°, excluding rim, 0.5 o.d. in length. Nuchal diameter 0.64–0.70 of oral. Shaft narrowly vase-shaped, with premedian bulge to greatest diameter of 0.67–0.74 o.d., at 0.35–0.50 t.l. below rim. Shaft subcylindridal above and an inverted, truncated, slightly convex cone of 12–17° below, with scarcely emergent pedicel below. Pedicel 0.50–0.75 o.d. in length, and 0.25–0.28 in diameter. Aboral flare feebly developed, a truncated cone of 5–11°, with length less than aboral diameter; in some loricæ again contracted distally for 0.33 aboral diameter in an inverted truncated cone of 20°, giving knob-like appearance to this region, but in some loricæ this terminal contraction slight. Aboral margin entire or undulating with fins extending beyond margin as blunt points. Aboral diameter at widest part 0.25–0.39 o.d. Fins 6–8, subequidistant, ribbon-like, extending upward 0.93 t.l. in a leiotropic course, arising at aboral margin or 0.3 aboral diameter above it, increasing evenly to an angle of 12–43° in uppermost part, nearly vertical in middle, becoming dextrotropic posteriorly for 1.0–1.5 aboral diameters, with a deflection of 15–18°; wider midway, decurrent above and below, falling short of rim about 0.1 o.d., reaching or even extending beyond aboral margin, or falling

short by 0.6 aboral diameter. Wall prismatic, soft in texture, easily deformed, though not so much so as in other species, its surface covered with varying amount of foreign detritus, never built into wall, never with coccoliths, thickening in bulge, and about aboral orifice. Animal with 2 oval, faintly refractive macronuclei, each 18 by 20μ, and 18 (16) membranelles. One individual at Sta. 4701 was seen in division, a new membranelle zone appearing laterally.

Five loricæ: L., total, 369–470 (418.8); fins, 347–416 (383.0). D., oral, 85–88 (86.6); midway, 55–65 (59.6); aboral, 22–36 (27.1)μ. One lorica was 315μ in length, with an oral diameter of 92μ; obviously flattened.

At 21 stations, viz., at 4, 1, 1, 3, 2, 2, and 8, respectively, in Mexican, Peruvian and South Equatorial currents, Panamic Area, Easter Island and Galapagos eddies, and Drift; at 68–85 (75.7)°; 24 loricæ.

Daturella striata Kofoid and Campbell

Plate 30, fig. 1

Lorica elongated, tapering, as a whole an inverted, truncated cone of 6–7°; 3.70–5.67 (5.10) o.d. Margin with flaring, feebly developed, but not reflexed rim, 1.67–2.40 aboral diameters in diameter. Suboral flare funnel-shaped, inverted, truncated, concave cone of 25–45°, 0.20–0.34 t.l. Shaft subconical, as a whole inverted, truncated cone of not over 5°, subcylindrical above, swollen near middle to 0.5–0.6 o.d., below bulge inverted truncated cone of 8–14°, contracting in lower end into imperfectly localized pedicel 1 o.d. in length, with slight aboral flare in truncated cone of not over 10°, 0.5 o.d. in length. Aboral margin entire, or slightly crenulated, with 12–16 serrations at end of striæ. Striæ 12–16, longitudinal, regularly spaced, subvertical anteriorly and slightly dextrotropic below middle, more strongly developed aborally, becoming indistinct above, and finally disappearing at 0.95–0.98 t.l. from aboral rim. Wall made up of fine prisms, 10–16 between striæ; uniformly thin, except for slight thickening midway. Wall soft, delicate, generally deformed in our collections. Foreign bodies freely agglomerated on its outer surface.

Three loricæ: L., total, 190–280 (243.0). D., oral, 44–65 (53.2); midway, 25–35 (32.0); aboral, 21–30 (26.5)μ.

At 7 stations, viz., at 1, 2, and 4, respectively, in California and Mexican currents, and Drift; at 69–84 (76.4)°; 9 loricæ.

49. SALPINGELLA Jörgensen emended Kofoid and Campbell emended

Salpingella, *partim*, K. and C., 1929, pp. 346–347 (see also Rhabdosella).
Salpingella (subgenus) K. and C., 1929, p. 349.

Salpingellinæ with elongated nail-, brad-, or trumpet-shaped loricæ; oral rim entire; suboral funnel present; shaft tapering or cylindrical above and inverted conical below; terminal aboral cylinder sometimes present; aboral end contracted, always open; shaft with vertical or spiral fins for part or whole of its length; wall hyaline, homogeneous, without evident primary structure; marine, eupelagic, mainly in tropical seas. Type species *Salpingella acuminata* (Claparède and Lachmann) Jörgensen emended K. and C., from the North Sea off Glesnæsholm, Norway.

One of the highest developments of the very diversified Tintinnidæ, as shown in elongated form, open posterior end, flaring collar, and spiral fins. Elongation and open aboral end are found also in Daturella, Salpingacantha, and Eutintinnus. Daturella and Salpingacantha also have fins. Daturella differs from Salpingella in having strongly developed prismatic structure, and fins extending whole length of lorica, a character in some species of Salpingella, but its pronounced prismatic structure, lack of differentiated collar, and less regular fins serve to distinguish it. Most species of Salpingella have a clearly differentiated collar, except *lineata* and *laminata*, but no species of Daturella has one. The thicker, softer, easily deformable wall of Daturella also stands in rather sharp contrast to the rigid wall of Salpingella. Principal difference between Salpingella and Salpingacantha is in character of oral margin, undulating or sharply toothed in the latter and always entire in Salpingella. Eutintinnus differs from Salpingella in having neither fins nor a highly differentiated collar, and in the wide open posterior end. Jörgensen's opinion that these toothed species of Salpingacantha are artifacts of species of Salpingella is as yet unproven. At least two lines of differentiation emerge from Salpingella into other genera. Thus, the development of facets, separated by angles instead of fins, results in Rhabdosella. In the other line, represented in the genus Epicranella, the development of a suboral necklace results from a modification due to fusion and symmetrical shaping of uppermost ends of the longitudinal ridges. Both genera have a basic Salpingella-like form with superposition of features differentiating them from Salpingella. Epicranella is foreshadowed in Salpingella by suboral ridges, which occur in *jugosa*, and by extension of fins in

costata and *regulata* onto the collar. Retraction of elevated fins in Salpingella to mere angles and flattening of interlamellar regions into plane facets assists in bringing about the generic characteristics of Rhabdosella.

Established by Jörgensen (1924, p. 13) who included in it all trumpet-like or nail-shaped, finned loricæ with contracted aboral regions but with open aboral end which had been included in Tintinnus by Claparède and Lachmann (1858), Entz, Sr. (1884), Daday (1887b), Brandt (1906, 1907), and Laackmann (1909). We (1929) excluded as Salpingacantha all loricæ with toothed or crenulated oral margin, and as Epicranella all with suboral necklace. At that time we included Rhabdosella in Salpingella as a subgenus with facets. We now raise this subgenus to generic rank. Salpingella, as thus delimited, is a homogeneous, coherent group of species which have clearly differentiated along their own sharply marked genetic lines. The genus Salpingacantha, in part at least, parallels Salpingella.

Contains 25 species, of which 17 are present in Expedition material; 2 others originally included in Rhabdosella as a subgenus of Salpingella are excluded. Of these 17 species, 4 are here described, viz., *incurva, laminata, sinistra,* and *tuba,* and 9 others were previously (1929) described by us. Subdivided into 3 series: the *lincata* series, including *lineata, laminata, curta, decurtata, faurei, costata, acuminatoides, laackmanni,* and *secata;* the *minutissima* series, including, *minutissima, altiplicata, sinistra, attenuata, acuminata, alata, ricta, gracilis,* and *tuba*; and the *rotundata* series, including *rotundata, subconica, incurva, jugosa, expansa, glockentögeri,* and *regulata.*

Salpingella acuminata (Claparède and Lachmann) Jörgensen, emended Kofoid and Campbell

Plate 33, fig. 7

Tintinnus acuminatus, Reichenow, 1927, p. 65, fig. 81_5.

Lorica moderately stout, trumpet-shaped, in some loricæ slightly tapering, or even curved; 7.0–11.6 (8.3) o.d. Oral margin slightly thickened, rounded, a bit incurved, and rarely slightly recurved, with asymmetrical sigmoid outline. Suboral funnel truncated, inverted, concave cone of 54–67°, and 0.04–0.16 t.l. Nuchal diameter 0.4–0.5 o.d. Shaft subcylindrical, 4.75–6.00 o.d. in length, tapering a little from throat 0.4–0.5 o.d. in diameter, decreasing aborally evenly and regularly, without local inflation or constriction in inverted, truncated

cone of not over 5°. Aboral region 2.25–3.00 o.d. in length, finned, contracting in a convex, inverted, truncated cone, increasing to 10°, except for tip, which contracts more abruptly (20–40°) for very short distance. Shaft rarely beset with regularly spaced, circular coccoliths of Syracosphæra (Brandt, pl. 67, fig. 1) confined to middle region of lorica. Aboral opening without differentiated projecting aboral cylinder, 0.13 o.d. in diameter. Fins 6–9, 0.18–0.35 (0.28) t.l., decurrent at both ends, subvertical anteriorly and leiotropic posteriorly (6°), or sometimes slightly leiotropic throughout (5–7°), widest toward middle. Wall with fine prisms are recorded by Brandt (pl. 68, fig. 5a), thickest in collar, thinning in shaft. Animal with 2 globular macronuclei, each 9μ in diameter, and 2 micronuclei, each 1.5μ in diameter. Sometimes 3 or 4 macronuclei are present, prior to fission. Wailes (1925, pl. 2, fig. 28) figures 10 membranelles on one side. Closing-apparatus, figured by Entz, Jr. (1908, pl. 5, fig. 3), some distance below nuchal level. The animal accumulates siderophile granules below the cytopharnyx, prior to fission. Hofker (1931b, pp. 394–396) conjectures that *acuminata* is a transition form between the Urostylidæ and the genus Laboea; all of which he places in the order Hypotricha. In this he completely disregards, for one thing, the differences in structure of the membranelles (cf. Campbell, 1930) in the Hypotricha and in the Tintinnoinea.

In about 60% of the loricæ of this species observed by the junior author in a surface plankton collection off La Jolla, California, an association with diatoms of the genus Gramatophora occurred. The diatoms formed a cuirass, or collar, embracing upper 0.3 of shaft. In two loricæ there was a double row of diatoms. The diatoms were alive and had nuclei, as did also the tintinnids. They were not built into the loricæ and could easily be dislodged by pressure, so that the association is probably a casual one.

Ten loricæ: L., total, 225–338 (302.8); fins, 63–130 (105.0). D., oral, 28–40 (36.4); midway, 14–20 (17.8)μ.

Varies from 225 to 338 (302.8)μ in Pacific material. These quite variable dimensions suggest correlation of length with temperature, smaller individuals appearing in warmer waters.

At 43 stations, viz., at 3, 4, 4, 6, 4, 2, and 20, respectively, in California, Mexican and Peruvian currents, Panamic Area, Easter Island and Galapagos eddies, and Drift; at 68–85 (76)°; 154 loricæ.

Salpingella attenuata (Jörgensen) Kofoid and Campbell

Plate 33, figs. 5, 6

S. secata, K. and C., *partim*, 1929, p. 348, fig. 683 (for p. 355 see *S. secata*).
S. acuminata, Hofker, 1931b, pp. 387–388.

Lorica very elongated, slender nail-shaped, tapering in aboral 0.14–0.24; 8.86–10.00 (9.35) o.d. Oral margin slightly thickened, slightly incurved, without distinct horizontal rim. Suboral funnel low, inverted, concave, truncated cone of 55–60°, 0.04 t.l. Nuchal diameter 0.45–0.50 o.d. Shaft cylindrical anteriorly, gradually tapering posteriorly, 0.96 t.l. Anterior cylindrical portion 0.76–0.86 t.l., 0.45–0.50 o.d. in diameter. Aboral region of shaft 0.14–0.24 t.l., a truncated cone of 6–8°, without distal local expansion. Diameter of truncated antapex 0.1 o.d. Aboral cylinder indistinct, sometimes projecting below fins. Fins 5–7, very low, blade-like, decurrent at both ends, 0.18–0.36 t.l., usually vertical or rarely slightly dextrotropic (5°), arising somewhat above antapex and terminating at, or beyond, anterior end of aboral cone. Wall thicker in collar than in shaft. Animal with 2 large oval macronuclei, each 8 by 12 μ. In one individual one macronucleus was larger, had a transverse reconstruction band, and was evidently in an early phase of division. Cytosome quite large, filling 0.8 of lumen, extending to aboral end. Hofker (1931b) counted 20 membranelles.

Eight loricæ: L., total, 248–313 (288.0). D., oral, 27–33 (30.8); midway, 11–15 (12.1) μ.

Larger in Mediterranean (Jörgensen, 1924, p. 14, 433 μ), in correlation with lower temperatures there as compared with those at which our material was collected.

At 7 stations, viz., at 1, 1, 2, 1, and 2, respectively, in California and Mexican currents, Easter Island and Galapagos eddies, and Drift; at 71–83 (76)°; 19 loricæ.

Salpingella curta Kofoid and Campbell

Plate 34, figs. 7, 9

Lorica like a small, stout test tube with blunt pointed end; 5.6–7.7 (6.2) o.d. Oral margin thin, up-turned. Suboral funnel a very low, inverted, truncated, barely concave cone of 50–60°, 0.05 t.l. Nuchal diameter 0.8 o.d. Shaft 0.9 t.l., cylindrical in anterior 0.75 t.l., with

diameter uniformly 0.8 o.d., merging gradually posteriorly into aboral cone. Aboral region truncated, slightly convex, inverted cone of 33°, contracting evenly and regularly toward antapex. Aboral cylinder 0.12 o.d. in diameter, with length 0.5 its diameter. Fins 6, blade-like, subvertical, or leiotropic (8–10°), decurrent at both ends, 0.35 t.l., extending a little distance on lower shaft. Wall uniform in thickness, except for thickening in aboral cone. Closing-apparatus low, conical, located 0.5 o.d. below rim. Animal with 2 oval or spherical macronuclei, each 5 by 8 μ, body filling 0.8 of lorica.

Five loricæ: L., total, 79–93 (87.2); from rim to origin of fins, 47–65 (57.8); from fins to aboral end, 26–32 (29.5). D., oral, 12–15 (14.0); midway, 9–13 (11.2); aboral, 2 μ.

The fins were leiotropic (8–10°) in one of our loricæ. A lorica from Sta. 4734 had a slight nuchal constriction and a submedian inflation, as in *laminata*.

At 7 stations, viz., at 1, 1, and 5, respectively, in Peruvian Current, Galapagos Eddy, and Drift; at 73–81 (76.7)°; 12 loricæ.

Salpingella expansa Kofoid and Campbell

Plate 34, fig. 10

Lorica elongated brad-shaped with truncated conical head; 11.6 o.d. Oral aperture with slightly thickened, not everted rim. Suboral funnel steep, tall, 0.04 t.l., inverted, truncated cone of 45°, slightly convex or slightly concave outwardly, with 4 short equidistant, decurrent suboral fins originating below brim of collar and running vertically down shaft for slightly more than oral diameter, highest (not exceeding 0.15 o.d.) at nuchal level, midway of length. Nuchal diameter 0.67 o.d. Shaft subcylindrical in anterior 0.96 t.l., without local changes in contour, changing to convex conical posteriorly. Posterior conical portion 0.33 t.l., inverted, truncated cone of 8°, with slight distal inflation, with abrupt, rounded aboral end below, with projecting aboral cylinder 0.11 o.d. in diameter and 0.33 as long as wide. Aboral fins 6, very low, decurrent at both ends, 0.43 t.l., subvertical and terminating anteriorly near lower end of cylindrical portion.

Two loricæ: L., total, 376–396; fins, 165. D., oral, 36–39; throat, 23; aboral cylinder, 5 μ.

At Sta. 4699, in Easter Island Eddy; at 75°; 1 lorica.

Salpingella faurei Kofoid and Campbell

Plate 34, fig. 1

Lorica quite elongated brad-shaped; 7.6–12.5 (10.4) o.d. Oral margin not peripherally everted or locally thickened as specialized rim. Suboral funnel well developed as truncated, inverted, concave cone of 56°; 0.06 t.l. Nuchal diameter 0.6 o.d. Shaft 0.94 t.l., cylindrical anteriorly, tapering posteriorly. Anterior tubular portion 0.54–0.56 t.l., circular in cross section, uniformly 0.6 o.d. in diameter. Aboral region 0.38–0.40 t.l., decreasing evenly in diameter, an inverted, truncated cone of 10–12°, with straight sides. Antapex truncated, open, without [?] terminal cylinder. Aboral diameter 0.12–0.19 o.d. Fins 7–9, 0.3 t.l., vertical or slightly leiotropic (8°), low, narrow, decurrent at both ends, and widest slightly below middle. Wall thickest in rim of collar and uniformly about half as thick elsewhere. Closing-apparatus conical, near throat. Animal with 2 oval, round, or even asymmetrical macronuclei, each 5 by 6 μ. Cytosome filling 0.8 of lorica.

Seven loricæ: L., total, 130–210 (155.4); to origin of fins, 98–152 (111.9); from origin of fins to aboral end, 28–53 (40.1). D., oral, 11–18 (14.9); midway, 7–9 (8.5); aboral end, 1–3 (2.3) μ.

At 12 stations, viz., at 1, 3, 1, 1, and 6, respectively, in California and Mexican currents, Panamic Area, Easter Island Eddy, and Drift; at 71–84 (78.9)°; 21 loricæ.

Salpingella glockentögeri (Brandt) Kofoid and Campbell

Plate 33, figs. 15, 16

Lorica much elongated, slender trumpet-shaped, with low flaring collar and shaft of uniform diameter in anterior 0.7 t.l., enlarged posteriorly; 8.3–11.2 (9.9) o.d. Oral margin everted horizontally into brim, with incurved edge, and thin definite rim. Suboral funnel low, widely flaring, an inverted, truncated cone of 90–105°, with sides asymmetrically concave outwardly, greatest diameter 1.08 o.d., and length 0.05–0.07 t.l. Nuchal diameter 0.35–0.40 o.d. Shaft very elongated, 0.93–0.95 t.l., 0.35–0.40 o.d. in diameter, uniform in anterior 0.7 t.l., or decreasing evenly as an inverted cone of 2° to posterior end of anterior portion. Aboral region always enlarged to not over 0.4 o.d. at 0.9 t.l. from anterior end of lorica, rounding off abruptly posteriorly to aboral cylinder, as long as wide, and 0.18–0.20 o.d. in diameter. Fins 5–7, very low, blade-like, decurrent at both

ends, 0.20–0.34 t.l., arising just above aboral cylinder, subvertical or leiotropic 5–12° from vertical axis, less than 0.1 o.d. in width at widest level (Brandt, pl. 68, fig. 1). Wall thickest in rim of collar, uniformly thinner elsewhere. Animal with 2 ovoidal, dense macronuclei, each 7 by 12 μ.

Three loricæ: L., total, 300–392 (341.0). D., oral, 35–37 (36.0); midway, 12–14 (13.1); inflation, 12–18 (14.0) μ.

At 2 stations, viz., at 1 each in Peruvian Current and Panamic Area; at 69–75°; 7 loricæ.

Salpingella gracilis Kofoid and Campbell

Plate 33, fig. 9

Lorica very elongated, very slender, tapering, trumpet-shaped, thin, and delicate; 9.8–13.3 (11.6) o.d. Oral margin slightly recurved in a thickened circumoral rim. Suboral funnel very low, rather wide, an inverted, truncated, deeply and asymmetrically concave cone of 98–110°; 0.05 t.l. Nuchal diameter 0.37–0.40 o.d. Outer surface of suboral cone of some loricæ with faint incipient ridges with a slight leiotropic twist. Shaft very narrow, elongated, tapering; its length 0.95 t.l.; its diameter, 0.37–0.40 o.d. at throat, decreasing evenly and regularly (2°), without local contractions or inflation to truncated, narrow aboral end, less than 0.1 o.d.; 0.34–0.36 o.d. in diameter midway of total length. Aboral cylinder rather indistinct. Fins 7–9, low, narrowly decurrent at both ends, 0.36–0.44 t.l., either leiotropic (3–6°) or vertical, very indistinct in some loricæ. Wall uniformly very thin, except in thicker collar. Animal with 2 (3) round macronuclei, each 6 by 8 μ. The individual with 3 macronuclei in an early phase of fission, with one macronucleus with a transverse reconstruction band.

Five loricæ: L., total, 320–434 (395.8); finned aboral region, 70–120 (93.0). D., oral, 34–37 (35.2); midway, 10–12 (11.0) μ.

At 7 stations in Drift; at 72–81 (75.8)°; 13 loricæ.

Salpingella incurva spec. nov.

Plate 33, fig. 8

Lorica very stout, shaped like a short brad with a rounded head; 6.6 o.d. measured on rounded rim. Oral margin thin, incurved, oral opening 0.89 diameter of widest part of convex region below it.

Suboral funnel bowl-shaped, with incurved margin, its lower part an inverted, truncated, convex cone of 55°, its length 0.06 t.l. Nuchal diameter 0.8 of greatest diameter above, or 0.9 o.d. Shaft subcylindrical in its upper 0.6, a convex, truncated, inverted cone of (20°) in its lower 0.4, forming aboral cone. Aboral end rounded, truncated, 0.2 of suboral diameter in diameter. No terminal cylinder. Fins 7, subvertical, decurrent at both ends, 0.35 t.l., widest (0.07 o.d.) near middle. Wall thickest in suboral bulge.

L., total, 135; aboral cone, 45. D., oral, 20; suboral bulge, 22; shaft midway, 17μ.

At Sta. 4717, in Galapagos Eddy; at 75°; 1 lorica.

Salpingella jugosa Kofoid and Campbell

Plate 33, fig. 17

Lorica moderately stout nail-shaped; 7.0–14.2 (8.4) o.d. Oral margin thickened, everted, with projecting brim 0.06 o.d. in width. Suboral funnel low, bowl-shaped, inverted, truncated cone of 53°, 0.07 t.l., with straight sides, with 6–7 narrow, equidistant, leiotropic (28–33°) surface ridges on outer surface, decurrent posteriorly and stronger anteriorly, below oral brim, extending on to upper end of shaft not over 0.5 o.d. Nuchal diameter 0.50–0.55 o.d. Shaft 0.93 t.l., cylindrical anteriorly, tapering posteriorly; anterior cylindrical part 0.67 t.l., its diameter uniformly that (0.50–0.55 o.d.) of throat; posterior 0.33 of shaft tapering, an inverted, truncated, distally convex cone of 15°, increasing to 25° near antapex. Aboral end without a projecting aboral cylinder, its distal diameter 0.09 o.d. Fins 6–7, 0.3–0.4 t.l., sometimes slightly longer than aboral cone, leiotropic (10°) in anterior 0.3, subvertical posteriorly, low, blade-like, and decurrent at both ends, with greatest width midway. Wall thicker in collar and uniformly thinner in shaft. Animal with 2 large oval macronuclei, 10 by 16μ.

Four loricæ: L., total, 312–396 (345.0); aboral conical section, 100–125 (110.0). D., oral, 38–49 (42.5); midway, 20–21 (20.2)μ.

At 4 stations, viz., at 1, 2, and 1, respectively, in Panamic Area, Easter Island Eddy, and Drift; at 74–80 (77)°; 4 loricæ.

Salpingella laminata spec. nov.

Plate 33, fig. 1

Amphorella obliqua, partim, Daday, 1887b, pp. 541–542 (see also *Tintinnus obliquus* and *Salpingella lineata*.

S. lineata, K. and C., *partim*, 1929, p. 354, fig. 678. See also *S. lineata* (Entz, Sr.).

Lorica stout, test tube-shaped; 4.9 o.d. Oral margin slightly flaring to thin edge, without thickened circumoral rim. Suboral funnel not differentiated from shaft, contracting gradually below rim in inverted cone of 15°, for 0.5 o.d. in length. Shaft subcylindrical in anterior 0.66, contracting to 0.77 o.d. at 0.26 t.l. from oral margin, increasing evenly to maximum diameter (1.0 o.d.) at 0.6 t.l. Aboral region forming posterior 0.34 of shaft, truncated, inverted, convex cone of 22°. Antapical cylinder 0.25 o.d. in diameter with length 0.5 its diameter. Fins 4, equal, equidistant, vertical, blade-like on posterior 0.4 t.l., arising just above aboral cylinder, widening on aboral cone to 0.14 o.d. in height, and continuing vertically as low ridges, almost vanishing midway, widening again to 0.04 o.d. in height below oral rim. Wall uniformly thin throughout. Animal with 2 ellipsoidal macronuclei, 6 by 4 μ, and 2 small spheroidal micronuclei.

L., total, 73. D., oral, 15; shaft, least diameter, 12, greatest, 14; aboral, 3.5 μ.

Included by us (1929, p. 354, fig. 678) in *lineata* (Entz, Sr.). Since Entz's figure (1884, pl. 24, fig. 21) shows no everted oral rim and has 10 aboral fins or striæ instead of 4 full-length ones, we now separate Pacific material from that of Entz from Mediterranean. Daday (1887b, pp. 541–542) included *Amphorella obliqua* based on Claparède and Lachmann's (1858, pl. 9, fig. 1) *Tintinnus obliquus* as a synonym of his *Tintinnus inquilinus* var. *lineatus* Entz, Sr. We are not in agreement with this decision, since *Tintinnus obliquus*, as figured by Claparède and Lachmann (1858, pl. 9, fig. 1), lacks fins or striæ, which are present on Entz's lorica. Accordingly, we leave *obliquus* Clap. and Lach. in Tintinnus *sensu stricto* with closed aboral end and associate with it *inquilinus* which has also a closed aboral end. In so doing we have also removed *obliquus* from Bursaopsis, in which genus we (1929) had placed it. For a discussion of this complicated situation see the synonymy of the genus Tintinnus.

At Sta. 4701 and 4709, in Drift; at 72°; 2 loricæ.

Salpingella minutissima Kofoid and Campbell

Plate 33, fig. 4

Lorica minute, depauperate, stout brad-shaped, with a very short shaft and short low fins; 3.3 o.d. Oral margin with thickened, peripherally everted rim. Suboral funnel widely flaring, inverted, truncated, slightly concave cone of 50°, 0.09 t.l. Nuchal diameter 0.5 o.d. Shaft stout, 0.91 t.l., cylindrical in anterior 0.63 t.l., merging below in aboral cone, uniformly 0.5 o.d. in diameter. Aboral region 0.37 t.l., tapering, convex-sided, inverted, truncated cone of 21°. Aboral terminal cylinder inconspicuous, slightly longer than wide, 0.12 o.d. in diameter. Fins 6, blade-like, decurrent at both ends, arising above aboral cylinder and continuing 0.37 t.l. in a leiotropic course, increasing anteriorly to 12°. Wall thickest in collar and uniformly thinner elsewhere. Animal with 2 oval macronuclei, each 6 by 9 μ.

L., total, 112; fins, 63. D., oral, 31; shaft, 12 μ.

At Sta. 4571, in California Current; at 71°; 1 lorica.

Salpingella ricta Kofoid and Campbell emended

Plate 33, fig. 10

S. ricta K. and C., *partim*, 1929, p. 354, fig. 672 (see also *S. tuba*).

Lorica elongated trumpet-shaped, with a long flare; 6.75–7.60 (7.17) o.d. Oral margin thickened in a horizontally everted rim. Suboral funnel a concave, inverted, truncated cone of 73–78° as a whole, or 45–58° proximally and 95–100° distally; 0.5 o.d., or 0.07 t.l. Nuchal diameter 0.26–0.33 (0.29) o.d. Shaft 0.95 t.l., or 0.62–0.80 (0.71) if measured to upper end of finned aboral section. Non-finned section cylindrical or slightly tapering as truncated, inverted cone of 3°. Aboral section finned, inverted, truncated, convex cone of 6–10°. Aboral cylinder very short, 0.5 its diameter in length and 0.06 o.d. in diameter. Fins 7, low, decurrent, 0.20–0.36 t.l., with dexiotropic torsion of not over 15° in middle part of course. Wall slightly thicker in funnel than in shaft. Animal filling 0.6 of shaft, with 2 oval macronuclei, 10 by 15 μ, and 2 small spherical micronuclei located on anterior ends of macronuclei.

Two loricæ: L., total, 340–390 (365.0); to fins, 225–320 (273.0). D., oral, 50–52 (51.0); midway, 15–17 (16.2) μ.

As here limited, *ricta* includes only that part of our original species with narrow, steep funnel and dexiotropic fins as represented in our

(1929, fig. 672) original figure. This results in modifications of our original description and distributional data.

At 7 stations, viz., at 1 and 6, respectively, in Panamic Area and Drift; at 70–81 (76.9)°; 12 loricæ.

Salpingella rotundata Kofoid and Campbell

Plate 34, fig. 5

Lorica small, with proportions and contour of a test tube; 7.0–8.8 (7.9) o.d. Oral margin thin, without a rim. Suboral funnel low, truncated, inverted concave cone of 67°, with asymmetrical sigmoidal outline, not over 0.06 t.l. Nuchal diameter 0.67 o.d. Shaft an almost perfect cylinder in adoral 0.7 its length, 0.67 o.d. at throat, increasing not over 10% in posterior 0.25 its length, causing a slight distal inflation, further exaggerated by fins. Aboral end subhemispherical, passing abruptly into aboral cylinder, projecting 0.1 o.d. in diameter, as wide as long. Fins 6, very low, vertical, ridge-like, abruptly decurrent some distance above aboral cylinder, 0.29–0.34 t.l. Wall uniformly thin throughout. Closing-apparatus diaphragm-like, in anterior end of shaft 1 o.d. below oral margin. Animal with 2 large oval macronuclei, each 10 by 12 μ, in one individual 10 by 18 μ, in a premitotic phase.

Three loricæ: L., total, 92–160 (118.6); to origin of fins, 63–100 (82.3); from fins to aboral end, 29–50 (39.3). D., oral, 13–18 (15.0); midway, 10–11 (10.3); aboral, 2.0–2.5 (2.25) μ.

At 4 stations in Drift; at 73–81 (77)°; 4 loricæ.

Salpingella secata (Brandt) Kofoid and Campbell

Pl3te 33, figs. 2, 3

S. secata, K. and C., *partim*, 1929, p. 335 (for fig. 683 see *S. attenuata*).

Lorica very slender trumpet-shaped or shaped like a stout finishing nail; 8.5–14.8 (9.4) o.d. Oral margin circular, very thin, and not everted in a specialized thickened rim, but may be slightly incurved. Suboral funnel an inverted, truncated funnel of 70–77°, 0.047–0.064 t.l., with sides convex above and concave below in a sigmoid outline. Nuchal diameter 0.39–0.50 o.d. Shaft very slender, 0.93–0.95 t.l., with diameter 0.39–0.50 o.d. at throat, cylindrical in upper 0.71–0.88 its length or expanding very slightly (8%) distally above fins. Aboral region a slightly convex cone of 2–3°, increasing to 16° below and 55° at rounded aboral end. Aboral cylinder 0.10–0.14 o.d. in diameter and

0.8–1.5 its own diameter in length. Fins 7–8, aboral, arising just above aboral cylinder, 0.3 t.l., decurrent at both ends, very gradually anteriorly, and ending abruptly posteriorly, widest below middle, subvertical in our loricæ, but leiotropic in Brandt's (pl. 66, fig. 5). Wall uniformly thin throughout (Brandt, pl. 66, fig. 5). Animal with 2 oval macronuclei, each 9 by 12μ.

Two loricæ: L., total, 340–408 (374.0). D., oral, 39–40 (39.5); midway, 20–21 (20.5); aboral, 5.5μ.

Rather variable in total length, 340–408μ in Expedition's loricæ and 260–300μ in Brandt's (1907).

At 6 stations, viz., at 1, 1, 1, and 3 in Mexican Current, Panamic Area, Easter Island Eddy, and Drift; at 72–83 (77.3)°; 10 loricæ.

Salpingella sinistra spec. nov.

Plate 33, fig. 14

Lorica slender, trumpet-shaped; 9.25 o.d. Oral margin without everted, locally thickened specialized rim. Suboral funnel a low, inverted, truncated, concave cone of 80°, 0.33 o.d. in length. Nuchal diameter 0.5 o.d. Shaft cylindrical, 7.4 o.d. in length, with a slight taper in distal 0.25 above fins. Aboral cone finned, 1.6 o.d. in length, an inverted, truncated, slightly convex cone of 10°. Aboral cylinder distinct, 0.12 o.d. in length and width. Fins 7, well developed, bladelike, on aboral cone, decurrent at both ends, 1.5 o.d. in length, leiotropic, 7° from vertical. Wall thicker in funnel and uniformly thinner elsewhere.

L., total, 245; aboral cone, 45. D., oral 26; midway, 12μ.

At Sta. 4703 in Drift; at 73°; 1 lorica.

Salpingella subconica Kofoid and Campbell

Plate 35, fig. 5

Lorica quite stout and brad-shaped; 5.4–8.8 (7.9) o.d. Oral aperture circular, not thinned down to a delicate margin, lacking locally thickened circumoral rim. Suboral funnel, a truncated, inverted, steep cone of 42–65°, quite concave outwardly; 0.06–0.08 t.l. Nuchal diameter 0.8–0.9 o.d. Shaft cylindrical anteriorly and tapering posteriorly. Anterior shaft 0.66–0.75 t.l., its diameter uniformly that of throat, 0.8–0.9 o.d. Posterior shaft an inverted, truncated, asymmetrically convex cone of 15–18°. Aboral orifice 0.2 o.d. in diameter, circular,

not projecting as a distinct aboral cylinder. Fins 7, rarely 8, low, blade-like, decurrent at both ends, 0.33–0.40 t.l., with greatest width (0.16 o.d.) midway, subvertical or dextrotropic (9–12°), more sharply twisted toward aboral end. Wall uniform in thickness throughout. Closing-apparatus conical, at base of collar. Animal with 2 spherical, ovoid, or irregular macronuclei, 5 by 5μ, 7 by 10μ, and 6 by 14μ, respectively, in different individuals. In one lorica a clear-walled, cyst-like body was located in oral end of shaft. Attached to some loricæ (Sta. 4587) are diatoms of the genus Gramatophora, encircling upper 0.3 of shaft, as in *acuminata*.

Ten loricæ: L., total, 138–220 (158.1). D., oral, 17–29 (21.3); midway, 13–18μ.

At 15 stations, viz., at 2, 2, 4, 2, and 5, respectively, in Mexican and Peruvian currents, Panamic Area, Galapagos Eddy, and Drift; at 68–85 (77.7)°; 31 loricæ.

Salpingella tuba spec. nov.

Plate 33, figs. 11–13

S. ricta K. and C., *partim*, 1929, p. 354 (for fig. 672 see *S. ricta*).

Lorica slender, elongated, trumpet-shaped, with an unusually wide, low flare; 5.5–6.5 (6.12) o.d. Oral margin thickened in a flattened, recurved rim. Suboral funnel very wide and low, not over 0.05 t.l. or less than 0.33 o.d., a deeply concave, inverted, truncated cone of 125–130°. Nuchal diameter 0.33 o.d. Shaft 0.95 t.l., almost cylindrical or tapering not over 3° to level of aboral fins. Aboral region contracting in an inverted, truncated cone of 3–4°, rounding in abruptly at aboral end. Aboral cylinder clearly differentiated, 0.1 o.d. in length, or 0.75–1.25 its diameter. Fins 6, low, vertical, or slightly dexiotropic, 0.26–0.42 t.l., decurrent aborally with an abrupt dexiotropic torsion. Wall thicker in suboral funnel, twice as thick in finned aboral region, uniformly thinner in bowl. Outer surface of suboral funnel with minute, faint, close-set longitudinal rugæ, not so distinct as the wrinkles in *Eutintinnus rugosus*. Animal filling 0.75 of lorica, with 2 oval macronuclei, each 10 by 16μ, and 2 adjacent spherical micronuclei, 2.6μ in diameter. Several individuals seen in division with lateral daughter cytostome clearly visible, and macronuclei with typical reconstruction bands, in some cases divided. Large, dense, oval or round bodies not of nuclear structure were found within the cytosome, comparable to those noted by Laackmann (1909, pl. 48, fig. 11) in *Daturella gaussi*.

Four loricæ: L., total, 340–388 (371); finned aboral region, 90–158 (122). D., oral, 60–62 (61); midway, 13–15 (14)μ.

Included by us (1929) in *ricta* because of comparable lengths. The structure of the suboral region is, however, so significant in speciation in this genus that we have here separated *ricta* of our *Conspectus* into two species, retaining in *ricta* only those loricæ with narrow, long funnels corresponding to our figure (1929, fig. 672) of *ricta*, and assigning those with the wide, low funnel to *tuba*.

At 5 stations, viz., at 1, and 4, respectively, in Galapagos Eddy and Drift; at 69–75 (72.2)°; 4 loricæ.

50. SALPINGACANTHA Kofoid and Campbell

Salpingellinæ with lorica elongated, attenuated posteriorly, generally a nail-shaped, posteriorly truncated, tapering tube, 6.4–13.6 o.d. in length; oral margin with (2) 3–7 or 12 blunt or short, triangular, flaring, erect, or incurved teeth; collar usually about 0.5 o.d. in length, funnel- or bowl-shaped, inverted, truncated subconical (33–50°), or forming only swollen bases of teeth; shaft elongated, cylindrical, or slightly tapering, usually uniform in anterior 0.5–0.8 t.l., sometimes swollen in middle; aboral region a narrow, inverted, truncated cone of 6–22°, fins 5–(7) 8, decurrent, low, blade-like, 0.20–0.52 t.l.; antapex with or without distinct terminal cylinder, always open; wall hyaline, undifferentiated; length, 90–400μ; panoceanic, arctic to tropical seas. Type species *Salpingacantha undata* (Jörg.) K. and C. from off Norway, as first figured by Brandt (pl. 67, fig. 10).

Closely resembles Salpingella, but differs from it in that oral margin is toothed or has at least the first phases in the formation of teeth, as in *perca*, in which they are mere minute marginal extensions of longitudinal folds. Parallels Salpingella in presence or absence of terminal cylinder. Toothed oral margin sets it off from Rhabdosella and Epicranella.

In this genus belongs a small series of species included by Jörgensen (1924) in Salpingella, whose validity he questions, claiming that *undata* and *unguiculata* are artificial forms produced by collapse of collar in certain mounting media (glycerin ?). The view of Jörgensen that the teeth are artifacts resulting from an inward collapse of upper part of suboral funnel induced by reagents such as glycerin, has some facts which support it. They are as follows: First, the loricæ in every species are Salpingella-like in every detail. Second, the artifact by collapse is

suggested by the irregularities in the circumoral lobes or teeth, especially in Brandt's (1906) figures. Third, the number of loricæ observed is quite small.

In rebuttal, there are several significant facts which convince us that until proved to be caused by reagents, or induced experimentally by aberrant behavior during the finishing touches of lorica formation, these circumoral denticles and lobes should be regarded as normal structures of systematic significance. These facts are as follows: First, the formation of circumoral teeth or of homologous structures of unquestionable normal character occurs in a number of widely separated genera of the Tintinnoinea, as, for example, in *Codonella poculum*, *Codonaria dadayi*, *Cyttarocylis magna*, many species of Cymatocylis, *Favella serrata* and *F. attingata*, nearly all species of Parafavella and of Ptychocylis, *Petalotricha serrata*, *Xystonella scandens*, *Xystonellopsis hastata*, *Dictyocysta spinosa*, *Odontophorella serrulata*, *Dadayiella ganymedes*, *Stelidiella stelidium*, and the subgenus Odontotintinnus of Eutintinnus. In none of these, however, are the projections so large or so few as in *Salpingacantha undata*, but they easily intergrade in these respects with the circumoral denticles in *S. perca* and *crenulata*. There is, therefore, nothing unusual or extraordinary in the denticulations of Salpingacantha, except the high level of differentiation attained in *undata*. In the second place, it is not possible to match up each species of Salpingacantha with one of Salpingella of which it might be a derived artifact. In the third place, the facts of occurrence and distribution are perfectly normal and afford no suggestion either of results of manipulation or of local conditions productive of artifacts. Species of Salpingacantha occur in the same collections with unmodified Salpingella and are not limited in occurrence to glycerin preparations or any group of reagents. The patterns of geographical occurrence are in no sense peculiar. The small number of individuals met with are paralleled in other highly differentiated genera of the Salpingellinæ, as, for example, in Epicranella. The regularity of denticulation in our species of Salpingacantha, such as in *perca* and *crenulata*, is also greater than in *undata* and *unguiculata* as figured by Brandt (1906). This eliminates to a large extent the argument for artifact raised by his figures. For these reasons we (1929) concluded that Salpingacantha is a valid genus.

Includes 7 species, of which 6 are present in Expedition material. Of these 6, 4 are described from Expedition material, and one other was given a new name by us (1929). Contains 1 series: *perca*, *crenulata*, *exilis*, *simplex*, *unguiculata*, *ampla*, and *undata*.

Salpingacantha ampla Kofoid and Campbell

Plate 34, fig. 13

Lorica elongated wire nail-shaped, but stout, due to sustained width of shaft; 10.7–13.2 (11.7) o.d. Oral margin with 5–8 low, claw-like, short, wide, triangular, inrolled, uniform sized teeth, with concave sides, 0.3 o.d. in length, with thickened margins. Oral margin rolled inwardly in interdental spaces in a deep spiral roll of greater extent and curvature than that shown by teeth, forming folds into cavity of collar at oral entrance. Teeth are not so large as those of *undata*. Suboral region subpolyhedral in cross section. Collar bowl-shaped because of incurvature of margin, 0.1 t.l., with convex sides bulging outwardly between teeth; below incurved circumoral rim with form of an inverted, truncated, convex cone of 30°. Nuchal diameter 0.6 o.d. Surface of collar with 4 or 6 longitudinal, decurrent, equidistant ridges, each 0.15–0.18 t.l., with upper ends some distance below oral margin, extending short distance down on shaft. Shaft elongated subcylindrical in upper 0.6, and an inverted, truncated cone below, its diameter 0.6 o.d. in nuchal region, increasing evenly to 0.7 below middle, circular in cross section at all levels. Posterior 0.4 of shaft an attenuated aboral cone of 16° contracting below in 20°, its diameter decreasing evenly to truncated posterior cylinder, with length less than diameter (0.12 o.d.), in some loricæ with a slight antapical flare changing cylinder to a small inverted funnel at end of lorica. Aboral fins 5, low, decurrent, blade-like, longitudinal, 0.4 t.l., equidistant, arising just above antapical funnel, slightly leiotropic, deviating from vertical not more than 3° in anterior 0.7, and confined to aboral cone. Wall subuniform in thickness. Animal with 2 subellipsoidal macronuclei, 10 by 11 μ.

Two loricæ: L., total, 306–358 (323.3). D., oral, 27–28 (27.3); midway, 18–19 (18.6) μ.

At 2 stations in Drift; at 72–81°; 3 loricæ.

Salpingacantha crenulata Kofoid and Campbell

Plate 34, fig. 4

Lorica stout brad-shaped; 6.4–7.7 (6.9) o.d. Oral margin incurved and strongly crenulated with 7–12 low, blunt or pointed, incurved teeth. Interdental regions and crenulations without thickened rim. Suboral funnel low, an inverted, truncated cone of 37–40°, 0.05–0.10 t.l., with sides outwardly convex above and straight or concave below,

without fins or ridges. Nuchal diameter 0.7–0.8 o.d. Shaft a cylinder of 0.7–0.8 o.d. in anterior 0.65 t.l., prolonged posteriorly as an inverted, truncated, convex cone of 18–20°, with subpolygonal cross section, decreasing uniformly aborally. Antapex truncate, 0.18–0.21 o.d. in diameter, vertical edges of adjacent slightly concave facets uniting in fin. Aboral fins 7, longitudinal, low, decurrent, blade-like, 0.35–0.40 t.l., extending to aboral margin, 0.16 o.d. in width, usually leiotropic 5° from the vertical posteriorly, with torsion sometimes increasing near upper end; in some loricæ with a distal dexiotropic torsion. No distinct aboral cylinder present. Animal with 2 oval macronuclei, 10 by 11 μ.

Five loricæ: L., total, 143–160 (150.0); fins, 40–54 (46.2). D., oral, 18–23 (19.6); midway, 14–16 (15.2); aboral, 3–5 (4) μ.

At 3 stations, in Drift; at 72–75°; 3 loricæ.

Salpingacantha exilis Kofoid and Campbell

Plate 34, fig. 11

Lorica very elongated, very slender brad-shaped, with minute collar; 10.0–13.6 (11.8) o.d. Oral margin with 12 regular, equidistant, low, triangular, outwardly flaring, thin teeth. Collar a very low, narrow-rimmed funnel, an inverted, truncated, concave cone of 75°, 0.4 o.d. in length. Nuchal diameter 0.60–0.65 o.d. Shaft a very slender, much elongated, gently tapering tube 0.97 t.l., uniformly tapering in anterior 0.8, an inverted cone of 2°; 0.60–0.65 o.d. in diameter at nuchal level, and 0.30–0.33 at anterior end of fins; posteriorly becoming aboral cone, a wider, truncated, inverted cone of 6–7°, 0.2 t.l. circular in cross section. Fins on cone 7 (8), very low, equidistant, decurrent, vertical or leiotropic (4°), blade-like. Aboral end simple, open, truncated. No differentiated terminal cylinder. Wall very thin. There is a complex conical diaphragm 0.7–0.9 o.d. below collar. Animal with 2 oval macronuclei, 4 by 9 μ.

Two loricæ: L., total, 147–219; fins, 24–37. D., oral, 14–16; midway, 7–8 μ.

At Sta. 4648, in Peruvian Current; at 71°; 2 loricæ.

Salpingacantha perca Kofoid and Campbell

Plate 34, fig. 12

Loricà short, stout brad-shaped, with full aboral region, 6.9 o.d. Oral margin almost entire, slightly incurved, without emergent teeth, only slightly angled, corresponding to teeth of other species. Angles

formed by longitudinal folds emerging as rounded elevations with plane or slightly concave margin between them. Collar a short funnel, an inverted, truncated, convex cone of 35–40°, 0.06 t.l., with 10 longitudinal, equidistant, slightly dexiotropic (6°), decurrent ridges higher anteriorly. Collar a 10-sided polygon in cross section as result of ridges. Nuchal diameter 0.75 o.d. Shaft as a whole 0.94 t.l., anteriorly an elongated cylinder in anterior 0.7 t.l., 0.75 o.d. in diameter, its surface free of ridges. Posterior portion an inverted, truncated, convex cone of 22°, 0.3 t.l. Antapex truncated, open, 0.19 o.d. in diameter. Aboral fins on surface of posterior cone, 5, low, equidistant, decurrent, equal, vertical, blade-like. Wall very thin. Closing-apparatus conical diaphragm-like, within upper 0.2 of shaft. Animal with 2 oval macronuclei, 5 by 8μ, with adjacent spherical micronuclei.

L., total, 90. D., oral, 21; shaft, 18μ. A second lorica collected by the senior author off Naples in 1908 was 124, 16, and 12μ. Our figure of *perca* (1929, fig. 690) measures 190μ in length at the stated magnification of x 200. The text (p. 357) correctly gives the length at 90μ.

Presents earliest phase in evolution of toothed oral margin where crenulations and denticulations of more highly developed species of the genus are represented only by the slightly emergent rounded ends of the suboral ridges. It differs from the faceted species of Rhabdosella in restriction of facets and ridges to collar region.

At Sta. 4709, in Drift; also off Naples (Kofoid); at 72°; 1 lorica.

Salpingacantha undata (Jörgensen) Kofoid and Campbell

Plate 34, figs. 3, 8

"Only an accidental form," Jörgensen, 1924, p. 14.

Lorica very large, extremely long, attenuated, nail-shaped, and with a widely expanded, bowl-like collar with 4 (2–6) claw-like teeth; 11.7–13.6 (12.7) o.d. Oral margin with 4–5 (Brandt, 1907, 2–6) large, sharply pointed, upright, outwardly convex, triangular, equidistant teeth. Interdental margin flattened as it rolls into oral cavity, forming a broad, much incurved shelf between teeth. Collar bowl-shaped, with convex sides, a flaring funnel, an inverted, truncated, very convex cone of 45°, 0.09 t.l., without fins or ridges. Nuchal diameter 0.75 o.d. Shape of oral aperture conditioned by number of teeth, subtriangular, squarish, or subhexagonal. In Brandt's lorica (pl. 67, fig. 4) the collar is merely the slightly expanded foundation upon which teeth are borne, suggesting his var. *unguiculatus* (pl. 67, fig. 6). We regard the assign-

ment of this lorica to *undata* as questionable and refer it to *unguiculata*. Shaft anteriorly subcylindrical, posteriorly a truncated cone of almost equal length. Anterior part cylindrical, 0.75 o.d. in diameter, 0.5 t.l. Posterior part of shaft an extremely long (0.43 t.l.), inverted, truncated cone of about 8°. Antapex simple, open, less than 0.1 o.d. in diameter. Fins 7 (8), longitudinal, decurrent, leiotropic (2°), equal, equidistant, blade-like, originating at aboral margin; 0.20–0.52 t.l. No differentiated aboral cylinder. Wall thin, increasing in collar. Animal with 2 or 4 oval macronuclei, 8 by 12μ; the greater number occurring in individuals in division.

Two loricæ: L., total, 320–400; fins, 76–180. D., oral, 23–35; shaft, 12–13μ.

First described by Jörgensen (1899) as a variety of *Tintinnus acuminatus*. Given specific rank by Brandt (pl. 67, figs. 3, 4, 10), who first figured it. He recorded 2–6 claw-like teeth and 7–8 fins, and notes lack of aboral cylinder below fins. Part of the material assigned to this species by Laackmann (1909) may belong here, but his figure (pl. 50, fig. 5) is *simplex*, since it is stouter, lacks much of a collar, and its oral margin is undulant. Meunier (1910, pl. 10, fig. 19) illustrates a lorica with only 2 teeth. This is possibly only a flattened or defective *Salpingella acuminata*, the figure being inadequately delineated and the magnification somewhat uncertain. Jörgensen (1924, p. 14) believes that this species is merely an accidental form produced by shrinkage in glycerin (?). Ours were examined in seawater to which formalin had been added.

At 2 stations, at 1 each in Easter Island Eddy and Drift; at 68–75°; 2 loricæ.

Salpingacantha unguiculata (Brandt) Kofoid and Campbell

Plate 34, figs. 2, 6

Tintinnus undatus var. *unguiculatus* Brandt, 1906, p. 32, pl. 67, fig. 11.

Lorica very slender, a tapering tube; 10.4–14.5 (12.0) o.d. Oral margin with 5–8 strong, sharp, low, incurved, triangular teeth, each with a broad base twice its length in width, with outwardly concave sides thickened and distinctly rounded. Margins of interdental regions deeply incurved for 0.20–0.24 o.d. and flattened. Brandt (1907, p. 392) finds 3–5 teeth in his material, while ours has 4, 6, or 8 teeth. Below the teeth there is a slight convex outward bulge, 0.5 o.d. in length, forming swollen base of claw-like teeth and completing collar. Nuchal

diameter 0.8–0.9 o.d. Shaft tubular, nearly uniform in diameter anteriorly for 0.8 t.l., its diameter 0.8–0.9 o.d., but sometimes swollen midway of total length to 0.85–1.00 o.d. (Brandt, pl. 67, fig. 2). Aboral region an inverted, truncated, slightly convex cone of 14°, decreasing uniformly to antapex. Fins (7)–8, low, decurrent, nearly vertical or leiotropic (6–8°), longitudinal, blade-like, and equidistant, 0.2–0.3 t.l. In individuals with antapical cylinder (Plate 34, fig. 6) fins arise above oral end of cylinder, otherwise (Brandt, pl. 67, fig. 2) only slightly above the simple, truncated, open aboral end. Some loricæ have antapical cylinder 0.25 o.d. in length, of nearly uniform diameter, resembling very closely that of *Salpingella secata* (Brandt, pl. 66, fig. 5), but relatively longer. Wall very thin, except for slightly thickened suboral region. Closing-apparatus low conical, diaphragm-like, of several blades in upper 0.1 t.l. Animal with 2 oval macronuclei, each 7 by 12 μ, cytosome in one instance containing numerous large, cyst-like food bodies (?). Siderophile material accumulates at time of fission above a lateral frontal-field anlage.

Five loricæ: L., total, 157–248 (204.0); to fins, 97–200 (141.0); fins, 48–77 (61.7). D., oral, 11–20 (17.0); midway, 9–14 (11.2); aboral, 3–4 (3.3) μ.

At 8 stations, viz., at 1, 1, 1, and 5, respectively, in California Current, Panamic Area, Galapagos Eddy, and Drift; at 68–81 (75.6)°; 10 loricæ.

51. RHABDOSELLA Kofoid and Campbell

Salpingella, *partim*, K. and C., 1929, pp. 346–347 (see also Salpingella).
Rhabdosella (subgenus) K. and C., 1929, p. 347.

Salpingellinæ with lorica stout trumpet- or nail-shaped; length 4.48–7.10 o.d.; oral margin entire, rimless, and always polygonal; collar funnel-shaped; shaft cylindrical or tapering, polygonal in cross section, either wholly or in part; no distinct aboral cylinder; aboral end open; wall with 8–20 facets either for the whole or a part of the length, hyaline, homogeneous; marine, eupelagic in Eastern Tropical Pacific. Type species *Rhabdosella cuneolata* (K. and C.) from Drift at Sta. 4730.

Close to Salpingella in general form and subdivision into suboral funnel, or collar, shaft, and aboral cone. *R. cuneolata* retains aboral fins characteristic of Salpingella and Salpingacantha. Rhabdosella is unlike either of these in polygonal cross section, either limited to anterior section or extending whole length of lorica. Faceted contour is definite, and angle formed at junction of plane faces never forms

projecting vertical fins. In *cuneolata* both suboral facets and aboral fins are present without correlation in number, a condition suggesting that angles between facets and fins are not homologous. There is a lack of any tendency toward development of suboral ridges in the form of a necklace, which distinguishes the related genus Epicranella. The facets suggest the similar feature of Dadayiella, but the lorica is open posteriorly, unlike that genus, which always has a closed aboral horn. Facets are developed in Ormosella also, but here again the lorica is closed at the aboral end. The wall is not prismatic or flaccid, as in Daturella, and has a trumpet-like form as against the tube-like one of Eutintinnus.

Originally described in subgeneric rank by us (1929) as a part of Salpingella, but now elevated to generic status because of its striking faceted structure, although its relationships with Salpingella are noted.

Contains *cuneolata* and *octogenata* from Expedition material.

Rhabdosella cuneolata (Kofoid and Campbell)

Plate 35, fig. 1

Lorica stout trumpet-shaped; 4.6–7.1 (5.3) o.d. Oral margin an 18- to 20-sided polygon, with straight, subequal edges, with no thickened rim and no eversion of margin. Collar a steep funnel 0.15 t.l., inverted, truncated, concave cone of 32–38°, merging gradually into shaft below, with outer surface shaped into 18–20 very faint, longitudinal, subequal facets with longitudinal boundaries marked by angles distinguishable with some difficulty. Both angles and intervening facets continued upon upper shaft to level of 0.33 t.l. below oral margin. Nuchal diameter 0.60–0.64 o.d. Shaft subcylindrical above, its length 0.85–0.90 t.l., its diameter above 0.6 o.d., with a polygonal cross section with 18–20 sides, becoming circular posteriorly below level of facets, tapering in posterior 0.3, inverted, truncated, slightly convex aboral cone of 12°. Antapex open, truncated, its diameter 0.06 o.d., not prolonged as distinct aboral cylinder. Fins (5) 6, low, blade-like, subvertical, decurrent at both ends, 0.4 t.l., ending slightly above truncated antapex and extending upon shaft slightly above aboral cone. Wall without prismatic structure, very thin anteriorly, somewhat thicker toward middle of shaft. The anteriorly faceted wall suggests a correlation in building between number of membranelles and number of facets (20). Animal with 2 ellipsoidal macronuclei, 5–7 μ by 2–3 μ, each with an adjacent globular micronucleus.

Eight loricæ: L., total, 163–266 (215.2); collar, 18–37 (27.7); cylindrical part of shaft, 67–123 (97.5); aboral cone, 63–120 (92.6). D., oral, 34–40 (36.4); midway, 17–22 (18.9) μ.

At 9 stations, viz., at 1, 1, 1, and 6, respectively, in Mexican Current, Panamic Area, Easter Island Eddy, and Drift; at 70–83 (75.5)°; 9 loricæ.

Rhabdosella octogenata (Kofoid and Campbell)

Plate 35, fig. 6

Lorica wide, tapering, faceted, trumpet-shaped; 4.48 o.d. Oral margin octagonal, with 8 straight, equal sides, not thickened in a rim or everted in a brim. Collar low funnel, 0.07 t.l., with outer surface divided into 8 equal plane facets by 8 longitudinal angles, slightly concave outwardly, inverted 8-sided pyramid of 50°, with octagonal cross section at all levels. Nuchal diameter 0.62 o.d. Shaft an inverted, elongated, 8-sided pyramid of 10°, with straight sides throughout, 0.75 t.l., decreasing from nuchal diameter (0.62 o.d.) evenly to 0.5 o.d. midway of total length, with surface divided into 8 equal, plane, longitudinal facets by 8 equidistant angles. Aboral region 0.25 t.l., continuing taper of shaft above, sharply twisted posteriorly in dextrotropic spiral at angle of 5°, increasing toward extremity to 20°, with facets changing from flat to rounded outer surface in twisted region. Antapex rounding off in inverted convex cone of 120°. Aboral end open, truncated, with diameter of 0.1 o.d. Wall uniform in thickness. Animal filling lower half of lorica.

L., total, 310. D., oral, 80; midway, 40; antapex, 6 μ.

At Sta. 4730, in Drift; at 79°; 1 lorica.

52. EPICRANELLA Kofoid and Campbell

Salpingellinæ with rather stout trumpet-shaped loricæ; 3.37–4.60 o.d. in length; oral margin entire, everted, circular, flaring in a horizontal or reflexed brim; collar funnel-shaped, an inverted, truncated cone with an elaborate suboral necklace of spiral ridges connected above by suboral arches; shaft proper cylindrical or subconical, usually faceted for a part or the whole of its length; aboral region convex subconical, contracting distally usually to terminal aboral cylinder; aboral end open; aboral region with spiral fins; wall hyaline, often with prismatic structure, especially in suboral region; length 235–348 μ. Eupelagic and eubathmic in Eastern Tropical Pacific. Type species *Epicranella prismatica* K. and C. from Sta. 4673 in Peruvian Current.

Epicranella is the climax of the structural evolution of the lorica and of lorica-forming behavior found in the Tintinnidæ. Much like Salpingella in structural features, such as suboral funnel, suboral and aboral fins, shaft, and aboral cylinder, but adds to these the suboral connecting arches, which, together with suboral ridges constitute the suboral necklace. This feature and stouter build, especially of aboral end, and faceting of suboral region or entire shaft, at once set it off from that genus. It has facets like Rhabdosella, but the latter lacks a suboral necklace, and Rhabdosella has a different type of aboral end and a less everted circumoral brim. The graceful symmetry and patterning of the lorica of this genus are indicative of a high degree of coordinated behavior on the part of the two daughter individuals, which presumably share in the shaping of the material of which the lorica is formed during the brief period of its plastic state.

Included, when founded by us (1929), 2 species, *bella* and *prismatica*, but closer inspection of the material discloses 3 others, *dextra*, *bellissima*, and *magnifica*, in Expedition material.

Epicranella bella Kofoid and Campbell

Plate 35, fig. 2

Lorica moderately slender screw-shaped, with narrow brim; 4.6 o.d. Oral margin rounded, abruptly everted, reflexed, with pronounced overhanging brim. Diameter of brim 1.94 diameters of shaft midway of its length, or 0.22 t.l. Collar very tall, slender, funnel-shaped, 0.2 t.l., or 1.0 o.d. in length, decreasing in diameter gradually in inverted, truncated, slightly concave cone of 25° as a whole, with diameter of 0.56 o.d. at lower end of cone and 0.85 at upper end below overhanging brim. Outer surface ribbed with 8 posteriorly decurrent, subequal, subequidistant, ascending leiotropic (20°) ridges with length equaling collar, becoming thicker and heavier as they ascend funnel, connecting at upper end one with another by thick, heavy, slightly arching, continuous horizontal beam, with its lower edge sculptured in a series of flattened arches, with an intercostal facet between adjacent ribs. Upper part of necklace hidden by wide, overhanging brim. Shaft proper 0.52 t.l., or 2.3 o.d. in length, cylindrical, with diameter 0.58 o.d. Facets continued for a short distance on upper shaft giving it an octagonal cross section, but rapidly becoming circular in shaft below. Aboral section tapering distally in inverted, truncated, convex cone of 20° as a whole, increasing to 30° distally; 0.33 t.l., or 1.5 o.d. in length. Aboral end squarely truncate, with diameter 0.13 o.d. Ridges on aboral

section 8, ascending, decurrent, rather unequal, arising at or near aboral margin and continuing upward with a leiotropic torsion of 20° for aboral 0.3 of their length, decreasing to 10–13° in upper part, thickest and widest near middle, and 0.19–0.34 t.l. Wall very thin generally, thickening at level of deepest portion of concavity of collar and more in rim, with subuniform inner and outer hyaline lamellæ and intermediate layer in facets of collar, with 4–6 subhexagonal secondary prisms between ribs. Wall elsewhere translucent and greenish. Animal filling 0.4 of cavity of lorica, with 2 large oval macronuclei, 10 by 16 μ, and numerous food bodies.

L., total, 312; collar, 50; shaft, 190; fins, 102. D., oral, 68; midway, 35 μ.

At Sta. 4675, in Peruvian Current; at 68°; 1 lorica. Type locality not Sta. 4713 previously reported by us (1929, p. 358) in error, but Sta. 4675.

Epicranella bellissima spec. nov.

Plate 35, fig. 3

Lorica tall, fairly stout, subcylindrical screw-shaped, with very wide brim; 4.0–4.12 o.d. Oral margin with wide, smoothly rounded, strongly everted, recurved, and overhanging brim with diameter 1.85 diameters of shaft midway of its length, or 0.24 t.l. Collar tall, funnel-shaped, 0.12 t.l., or 0.5 o.d. in length, decreasing evenly and symmetrically aborally to 0.63 o.d. from 0.81 o.d. below recurved brim, with rather flat sides, except where modified by heavy spiral ribs, forming an inverted, truncated cone of 30–35°. Outer surface of collar ribbed with 12 posteriorly decurrent, subequidistant, ascending leiotropic (27–36°) ridges with a length of 0.6 o.d., arising immediately at, or below, lower end of funnel, becoming thicker and heavier anteriorly, and connecting at oral end one with another by thick, heavy, horizontal, continuous, band-like beam beneath brim, with its lowermost edge sculptured as a series of flattened arches, with flattened intercostal facet between each two ascending ribs. Upper portion of sculptured region partially hidden by overhanging brim, exposed by tipping lorica. Nuchal diameter 0.63 o.d. Shaft 0.47 t.l., or 2.23 o.d. in length, cylindrical, circular in cross section, without facets. Posterior section an inverted, truncated, convex cone of 22° as a whole, increasing to 40° distally, with length 0.41 t.l., or 1.57 o.d. Aboral end 0.13 o.d. in diameter. Aboral region with 7–8 interrupted, ascending, decurrent, leiotropic (27–37°), low folds, with vertical length 0.31–0.35 t.l. Wall very thin, increasing in brim, fairly uniform at other levels, translu-

cent, greenish, with uniform, homogeneous inner and outer lamellæ, and strongly prismatic intermediate substance below suboral necklace, with 14–16 subequal, sharply angular, triangular to hexagonal secondary prisms in single layer across middle of shaft.

Two loricæ: L., total, 312–318; funnel, 24–37; shaft, 175–180; folds, 100–114. D., oral, 74–78; midway, 40μ.

At 2 stations, 1 each in Peruvian Current and adjacent Drift; at 71–72°; 2 loricæ.

Epicranella magnifica spec. nov.

Plate 35, figs. 7, 8

Lorica quite stout, screw-shaped, and with wide flat funnel; 3.37 o.d. Oral margin rounded, widely everted, slightly recurved in projecting brim with diameter 1.94 diameters of shaft midway of length, or 0.27 t.l. Collar tall, funnel-shaped, 0.12 t.l., or 0.46 o.d., inverted, truncated, quite concave cone of 52° measured below brim, decreasing evenly in diameter aborally and merging gradually below with shaft at 0.81 o.d. below recurved brim, with sides gracefully concave with deeper portion of concavity below middle. Outer surface ribbed with 11 posteriorly decurrent, subequidistant, ascending, subvertical to leiotropic (25°) ridges, with subequal lengths of 0.48 o.d., arising below lower end of funnel, becoming thicker and heavier above, and connecting at oral ends below recurved brim one with another by rounded, asymmetrically curved, raised transverse arches bordering underside of circumoral brim, with flattened intercostal facet enclosed by each arch, with marginal rib on either side. Nuchal diameter 0.61 o.d. Shaft proper 0.6 t.l., or 2.0 o.d. in length, cylindrical, with approximately same diameter (0.6 o.d.) at all levels, circular in cross section, with no trace of facets which make funnel above angular. Aboral cone inverted, truncated, convex cone of 22°, 0.28 t.l., or 1.07 o.d. in length. Aboral end truncated, open, 0.1 o.d. in diameter. Fins on aboral section 8, wide, subequidistant, blade-like, 0.06 o.d. in width at middle, decurrent at both ends, arising at aboral end around its aperture and continuing upward with leiotropic torsion of 23° in lower 0.3, and not over 12° above; 0.29 t.l., or 1.21 o.d. in length. Wall uniformly thin at all levels, highly translucent, with greenish cast, with thin, hyaline inner and outer lamellæ and a coarse, irregular, thin walled, secondary prismatic structure best seen in region of suboral necklace, made up of pentagonal or hexagonal secondary prisms (Plate 35, fig. 8), 7–9 prisms between each pair of ribs.

L., total, 235; collar, 20; shaft, 140; fins, 75. D., oral, 70; midway, 70μ.
At Sta. 4715, in Galapagos Eddy; at 75°; 1 lorica.

Epicranella dextra spec. nov.

Plate 35, fig. 4

Lorica subcylindrical, stout, screw-shaped, with a wide brim; 3.94 o.d. Oral margin has a smoothly rounded, everted, strongly reflexed, overhanging brim with a diameter of 2.1 diameters of shaft midway of its length, or 0.26 t.l. Collar funnel-like, 0.19 t.l., or 0.77 o.d. in length, decreasing in diameter aborally to 0.55 o.d., with diameter at oral end below recurved brim of 0.92 o.d., inverted, truncated cone of 35°, with sides deeply and asymmetrically concave, with outer surface ribbed with 14 posteriorly decurrent, subequidistant, ascending *dextrotropic* (22–33°) ridges with length 0.60–0.75 o.d., arising near lower end of funnel and connecting anteriorly each with its neighbor by a low suboral connecting arch-like ridge, bounding anterior end of each intercostal facet and forming, with aid of ascending ridges, the suboral necklace; arches almost hidden beneath overhanging brim of oral aperture. Nuchal diameter 0.55 o.d. Shaft proper 0.5 t.l., or 2.0 o.d. in length, truncated, slightly concave cone of 4°, with diameter at aboral end 0.47 o.d., faintly but definitely faceted or polygonal in cross section in its anterior 0.3, and passing gradually below that level into a circular section for remainder of its length. Facets 14, continuing the intercostal ones above. Aboral section inverted, convex subconical, increasing to 45° distally, 0.36 t.l., or 1.3 o.d. in length, subdivided into short anterior section and longer posterior cone. Anterior section convex subcylindrical, about 0.33 length of whole section, with diameter at widest part 0.6 o.d. Posterior section inverted, truncated, convex cone of 21° as a whole, with length of 0.66 of whole section. Aboral cylinder short, 0.08 o.d. in diameter and length. Aboral region with 16 unconnected dextral (12–24°) folds, some becoming subvertical at oral ends, originating just above aboral cylinder, not over 0.33 t.l. Wall very thin, increasing in brim, uniform at all other levels, with uniform, homogeneous inner and outer lamellæ, faintly reticulated with an irregular polygonal mesh between lamellæ, very hyaline, with greenish cast. Prisms 3–5, across each intercostal space, changing at lower end of suboral necklace to zone of finer and heavier-walled prisms.

L., total, 322; funnel, 27; shaft, 173; folds, on the slant, 120. D., oral, 82; midway, 39μ.

At Sta. 4721, in Drift; at 75°; 1 lorica.

Epicranella prismatica Kofoid and Campbell

Plate 35, figs. 9, 10

Lorica large, tall, slightly tapering nail-shaped, faceted for entire length; 4.5 o.d. Oral margin rounded, widely everted horizontally, slightly reflexed, with wide overhanging brim, 2.52 diameters of shaft midway of its length, or 0.23 t.l. Collar tall, funnel-shaped, 0.08 t.l., or 0.5 o.d. in length, inverted, truncated, deeply convex cone of 45°, decreasing regularly in diameter below to 0.55, with diameter below brim 0.8 o.d. Outer surface ribbed with 12 posteriorly decurrent, subequal, subequidistant, ascending leiotropic (20°) ridges, 1 o.d. in length, thickening and standing out in relief from surface as they ascend, connecting one with another by raised, transverse, flattened arches. Facets between ridges 12, subrectangular, intercostal, at first leiotropic but becoming vertical on shaft. Transverse beams below overhanging brim visible from side. Ascending ridges sometimes projecting above arches as short knobs on under side of recurved brim. Shaft 0.73 t.l., or 3.35 o.d. in length, inverted, truncate subpyramidal (4°), with 12 flat, subequal sides in upper 0.3, number of sides decreasing to 10 by fusion toward middle, and 10 again by fusion decreasing to 8 in lower 0.3 of shaft, successive cross sections dodecagonal, decagonal, and octagonal. Fusion of facets is accomplished by the narrowing down of eliminated facet as a triangular, flat tongue. Diameter of shaft at its lower end 0.43 o.d. Aboral section inverted, truncated, subpyramidal (12°), moderately convex, 0.27 t.l., or 1.23 o.d. in length. Aboral cylinder 0.14 o.d. in diameter and 0.10 in length. Aboral end open. Of the 8 subequal sides of this section, the 4 alternating ones weaker and less plainly angular, the other 4 sharper and clearly angular. Fins of posterior section 8, low, ridge-like, slightly leiotropic (3°), originating above upper end of aboral cylinder as decurrent blades, subequal and subuniform, 1.37 o.d. in length, reaching maximum width at middle. Wall uniformly thin throughout, except for thickening in brim, composed of equal inner and outer lamellæ, uniform in texture throughout, homogeneous, very hyaline, slightly greenish, with intermediate layer reticulated with an irregular polygonal network of 3–7 prisms across a single intercostal space, fading out near suboral necklace, giving way to a zone of finer prisms with heavier walls. Finer prismatic structure not made out elsewhere in lorica.

Animal with 2 ellipsoidal macronuclei, 10μ by 16μ, and 2 adjacent spherical micronuclei. In one individual in division a lateral frontal field was present, similar to that found by Campbell (1929) in *Tintin-*

nopsis reflexa. This animal had 4 macronuclei. A large, oval, cyst-like body with 2 oval nuclei was present in another individual.

It seems very doubtful to us that the loricæ of a compact group such as the Tintinnoinea are built up in fundamentally different ways, as suggested by Jörgensen (1924, p. 6). We see little evidence in this group of any differences in the structure of the lorica between aborally open and aborally closed types; certainly fission in the animal and the accumulation of siderophile substances used in forming the lorica are wholly alike in the animals forming the two types of loricæ. This siderophile aggregation in *prismatica* is quite like that found in other Tintinnoinea with closed aboral ends or in those more widely open.

L., total, 348; suboral flare, 38; shaft, 205; fins, 114. D., oral, 77; midway, 36μ.

At 8 stations, viz., at 2, 1, and 5, respectively, in Peruvian and South Equatorial currents, and Drift; at 67–81 (74.5)°; 8 loricæ.

STATION RECORDS

The frequency of each species identified in each haul at the collecting stations on the route is listed as a percentage of the first hundred loricæ met with and identified in the examination of the microplankton with the aid of a mechanical stage. Overruns beyond one hundred as a rule are entries of 1% added for species identified after the first hundred were counted. In a few of the richer hauls more than one hundred loricæ were counted and the percentages adjusted to the total. In some of the scanty collections it was not possible to find one hundred loricæ in the examination of many slides. In such cases the percentages were computed on this smaller number. The stations are listed in the chronology of the cruise. The order of genera in the lists is that of treatment in text, and that of the species is alphabetical under the genus.

ABBREVIATIONS: — Acanthostomella, ACAN.; Albatrossiella, ALB.; Amphorella, AMPH.; Amphorellopsis, AMPHS.; Amplectella, AMPL.; Amplectellopsis, AMPLS.; Brandtiella, BDT.; Canthariella, CANTH.; Climacocylis, CLIM.; Codonaria, CDNR.; Codonella, COD.; Codonellopsis, CDLLPS.; Codonopsis, CDPS.; Coxliella, COX.; Craterella, CRAT.; Cricundella, CRIC.; Cyttarocylis, CYTT.; Dadayiella, DAD.; Daturella, DAT.; Dictyocysta, DICT.; Epicancella, EPIC.; Epicranella, EPICR.; Epiorella, EPIOR.; Epiplocylis, EPIP.; Epirhabdonella, EPIRH.; Eutintinnus, EUT.; Favella,

FAV.; Helicostomella, HELIC.; Metacylis, MET.; Odontophorella, ODONT.; Ormosella, ORM.; Parundella, PAR.; Petalotricha, PET.; Porœcus, POR.; Proplectella, PROP.; Prostelidiella, PROST.; Protorhabdonella, PROTORH.; Rhabdonella, RHAB.; Rhabdonellopsis, RDPS.; Rhabdosella, RHABDS.; Salpingacantha, SALPGC.; Salpingella, SALP.; Steenstrupiella, STEEN.; Stelidiella, STEL.; Stenosemella, STEN.; Tintinnopsis, TPS.; Undella, UND.; Undellopsis, UDPS.; Xystonella, XYST.; Xystonellopsis, XPS.

California Current. Stations 4571–4583

4571. 33° 40′ N.; 119° 35′ W. 7–X–'04. 71° F at surface.

Surface: 100 loricæ counted; 131 identified; 12 spp.:

EPIP. undella 1%; RHAB. hebe 49, spiralis 14, striata 8; XYST. longicauda 1; STEEN. steenstrupii 2; AMPH. quadrilineata 3; EUT. brandti 1, elongatus 22, lusus-undæ 2, medius 1, tenuis 1.

300–0 fms.: 100 loricæ counted; 113 identified; 41 spp.:

COD. aspera 1%; CLIM. elongata 1, scalaria 1; CYTT. eucecryphalus 1; EPIP. blanda 6, impensa 1; RHAB. chiliensis 1, hebe 2, inflata 2, spiralis 1, striata 1; PAR. caudata 4; XYST. treforti 9; XPS. abbreviata 4, favata 1, ornata 16, pulchra 1, torta 4; PROP. fastigata 2, parva 4; UND. hemispherica 2, hyalinella 1; DICT. ampla 9, dilatata 1, minor 1, mitra 1, mulleri 1, pacifica 1; AMPHS. lævis 1; DAD. acutiformis 5, bulbosa 2, cuspis 2, ganymedes 1; EUT. elongatus 1, tenuis 9; DAT. magna 1, striata 3; SALP. acuminata 1; attenuata 1; faurei 1; minutissima 1.

4574. 30° 35′ N.; 117° 15′ W. 8–X–'04. 69° F.

Surface: 100 loricæ counted; 114 identified; 14 spp.:

CYTT. eucecryphalus 4%, longa 1, magna 1; EPIP. constricta 1, pacifica 19; RHAB. hebe 6, quantula 6, striata 14; STEEN. steenstrupii 10; AMPH. quadrilineata 2; EUT. birictus 1, elongatus 4, medius 28, tenuis 5.

300–0 fms.: 100 loricæ counted; 141 identified; 44 spp.:

COD. brevicollis 1%, pacifica 1; CDLLPS. speciosa 9; COX. declivis 1; CLIM. scalaria 2; CYTT. acutiformis 4, eucecryphalus 16, longa 3, magna 6; EPIP. lata 1, pacifica 3, symmetrica 1; PET. capsa 2, major

7, pacifica 4; PROTORH. simplex 1; RHAB. quantula 2, valdestriata 1; RDPS. intermedia 1; XYST. treforti 7; XPS. abbreviata 1, favata 1, gaussi 1, ornata 3, pulchra 5; PROP. parva 1, subangulata 2; UND. declivis 1, hyalina 3, mammilata 1; UDPS. pacifica 1; DICT. californiensis 1, mexicana 1, minor 2, mitra 1, mulleri 2, occidentalis 1, reticulata 2, tiara 1; STEEN. steenstrupii 2; EUT. elongatus 2, lusus-undæ 6; SALP. acuminata 1.

4576. 29° 52′ N.; 116° 56′ W. 8–X–'04. 69° F.

Surface: 100 loricæ counted; 124 identified; 26 spp.:

COD. elongata 1%; COX. declivis 1, laciniosa 1, longa 1; CYTT. eucecryphalus 1; EPIP. blanda 6, constricta 1, exquisita 3, impensa 1, pacifica 13, symmetrica 1; PROTORH. simplex 1; EPIRH. coronata 1, mucronata 2; RHAB. hebe 43; RDPS. intermedia 1; STEEN. gracilis 1, robusta 1, steenstrupii 9; AMPH. quadrilineata 1; EUT. biriętus 1, brandti 1, elongatus 8, medius 8, tenuis 5, turgescens 1.

4580. 24° 55′ N.; 112° 45′ W. 10–X–'04. 76° F.

Surface: 100 loricæ counted; 262 identified; 42 spp.:

COD. acuta 2%; CDLLPS. americana 1; COX. longa 1; CLIM. scalaria 2; CYTT. acutiformis 1, eucecryphalus 2, longa 1; EPIP. blanda 6, constricta 14, impensa 1, undella 12; EPIOR. acuta 6; PROTORH. curta 1, simplex 2; EPIRH. coronata 1; RHAB. aberrans 1, amor 4, conica 3, cornucopia 1, hebe 2, poculum 1, quantula 10, spiralis 1; XYST. treforti 1; XPS. acuminata 1, armata 1, tropica 1; PROP. globosa 1, parva 2; UND. hemispherica 1; DICT. mulleri 1; AMPH. quadrilineata 1; DAD. ganymedes 2; EUT. elongatus 8, fraknóii 1, lusus-undæ 1, medius 2, pinguis 5, stramentus 1, tenuis 22, turgescens 1; SALPGC. unguiculata 2.

300–0 fms.: 100 loricæ counted; 110 identified; 47 spp.:

COD. cuspidata 1%, galea 2; CDNR. cistellula 1, mucronata 1; CLIM. scalaria 6; MET. conica 1; CYTT. acutiformis 1, cassis 1, eucecryphalus 4, longa 6, ricta 2; EPIP. blanda 3, pacifica 7, symmetrica 4, undella 10; EPIOR. acuta 2; PROTORH. simplex 1; RHAB. amor 4, conica 3, poculum 2, quantula 4, spiralis 1, valdestriata 1; RDPS. triton 3; XYST. treforti 1; XPS. heroica 1, ornata 1; PROP. fastigata 1, perpusilla 2, subangulata 1; UND. bulla 1, dilatata 4, hyalina 1, media 1, ostenfeldi 1, pistillum 1; AMPL. monocollaria 1; UDPS.

pacifica 1; DICT. ampla 1, mexicana 1, mulleri 2, occidentalis 1, reticulata 5; STEEN. steenstrupii 2; EUT. pinguis 1, tenuis 7, turgescens 1.

4583. 22° 45′ N.; 110° 5′ W. 11–X–'04. 83° F.

Surface: 100 loricæ counted; 1212 identified; 50 spp.:

COD. acuta 2%; CDNR. lata 1; STEN. nivalis 1; CDLLPS. meridionalis 8; CLIM. digitula 5, scalaria 1, scalaroides 2; MET. lucasensis 1; CYTT. acutiformis 1, longa 1; POR. apiculatus 1; FAV. panamensis 1; EPIP. blanda 1, constricta 1, deflexa 1, pacifica 1, undella 1; EPIOR. acuta 1; PROTORH. curta 1, simplex 1; RHAB. conica 2, cornucopia 1, exilis 1, hebe 2, poculum 1, quantula 31, spiralis 4, striata 5; RDPS. intermedia 34; XPS. acuminata 1, hastata 1; PROP. claparèdei 1, perpusilla 1; UND. hemispherica 1, hyalina 1; DICT. mexicana 1, reticulata 1; STEEN. gracilis 1, steenstrupii 1; AMPH. minor 2, quadrilineata 1; EUT. brandti 1, elongatus 3, lusus-undæ 1, medius 1, pinguis 3, stramentus 1, tenuis 1, turgescens 1; SALP. acuminata 1.

300–0 fms.: 100 loricæ counted; 149 identified; 65 spp.:

COD. acuta 2%, apicata 1, cuspidata 1, elongata 1, galea 5; CDNR. cistellula 1, lata 1, mucronata 3; CDLLPS. californiensis 1, meridionalis 1, minor 1, turgescens 4; CLIM. scalaria 2, sipho 1; CYTT. acutiformis 3, cassis 1, eucecryphalus 1, longa 7; EPIP. blanda 1, constricta 1, impensa 1, pacifica 1, undella 2; PROTORH. simplex 1; RHAB. conica 4, quantula 4, spiralis 2, torta 1, valdestriata 1; RDPS. intermedia 6, triton 3; XYST. longicauda 1, treforti 1; XPS. abbreviata 1, acuminata 1, armata 3, hastata 1, heroica 1, ornata 1, paradoxa 1, pulchra 7, tropica 1; PROP. claparèdei 1, perpusilla 13, tenuis 1; UND. bulla 1, hyalina 3, media 2, pistillum 1; AMPL. monocollaria 1; UDPS. insignata 1, pacifica 1, tricollaria 1; DICT. ampla 1, californiensis 1, mexicana 4, mulleri 1, occidentalis 1, reticulata 1; AMPH. quadrilineata 1; EUT. elongatus 3, perminutus 1, stramentus 1, tenuis 2; SALP. acuminata 1.

Mexican Current. Stations 4587–4607

4587. 20° 42′ N.; 107° 25′ W. 12–X–'04. 82° F.

300–0 fms.: 120 loricæ counted; 120 identified; 46 spp.:

COD. acuta 1%, apicata 2, cuspidata 1, galea 1, rapa 1; CDNR. australis 2, cistellula 1, mucronata 1; CDLLPS. americana 3, meridionalis 7, minor 1, turgescens 2; CLIM. scalaria 13; HELIC. longa; CYTT.

acutiformis 5, longa 9; FAV. azorica 2; EPIP. constricta 1, lata 1; PET. foli 3; RHAB. amor 1, conica 5, cuspidata 1, quantula 1, spiralis 1; RDPS. intermedia 1, triton 3; XYST. treforti 1; XPS. acuminata 1, armata 1, dahli 1, pulchra 6, tropica 2; PROP. claparèdei 2, perpusilla 1; UND. hyalina 3; AMPL. monocollaria 1; AMPH. quadrilineata 1; DAD. bulbosa 1; EUT. brandti 2, elongatus 2, tenuis 6; DAT. stramonium 2; SALP. acuminata 2, faurei 1, subconica 1.

4588. 19° 52′ N.; 106° 22′ W. 12–X–'04. 81–83° F.

Surface: 50 loricæ counted; 54 identified; 17 spp.:

COD. acuta 2%, apicata 2; CLIM. scalaria 2; FAV. panamensis 2; EPIP. constricta 1, undella 2; RHAB. amor 1, conica 52, cuspidata 6, quantula 3, spiralis 7; STEEN. steenstrupii 4; AMPH. quadrilineata 8; EUT. elongatus 1, pinguis 4, stramentus 6, tenuis 1.

4590. 18° 50′ N.; 104° 50′ W. 13–X–'04. 82–83° F.

300–0 fms.: 100 loricæ counted; 164 identified; 50 spp.:

COD. acuta 3%, apicata 1, galea 5; CDNR. australis 2; CDLLPS. californiensis 1, meridionalis 8, minor 4, turgescens 11; CLIM. scalaria 1; CYTT. acutiformis 1, eucecryphalus 1, longa 2; EPIP. blanda 5, constricta 1, deflexa 4, pacifica 1, undella 1; PET. capsa 2, foli 1; PROTORH. simplex 1; RHAB. amor 1, conica 5, cuspidata 1, quantula 1, spiralis 2; XPS. heroica 1, tenuirostris 5, tropica 1; PROP. claparèdei 5, fastigata 1, ovata 1, perpusilla 3; UND. dilatata 2; DICT. mexicana 1, pacifica 1, reticulata 2; DAD. acutiformis 1; BDT. palliata 1; EUT. brandti 1, elongatus 1, fraknóii 1, procurrerens 1, tenuis 7; DAT. stramonium 1, striata 1; SALP. acuminata 2, attenuata 1, faurei 2, secata 4; RHABDS. cuneolata 1.

4592. 18° 20′ N.; 103° 40′ W. 13–X–'04. 84° F.

Surface: 100 loricæ counted; 171 identified; 31 spp.:

TPS. karajacensis 1%, radix 6, sacculus 1; STEN. nivalis 2; CDLLPS. americana 10, meridionalis 1; CLIM. scalaria 1; CYTT. longa 1; FAV. panamensis 2; EPIP. undella 2; EPIOR. acuta 2; PROTORH. simplex 1; RHAB. amor 1, cornucopia 12, cuspidata 2, poculum 2, quantula 4, spiralis 2; PROP. claparèdei 1, cuspidata 1, perpusilla 1; UND. hemispherica 1; DICT. mexicana 1, reticulata 1; STEEN. robusta 4, steenstrupii 1; AMPH. minor 3, quadrilineata 15; EUT. elongatus 16, pinguis 1, stramentus 2, tenuis 3.

4594. 17° 20′ N.; 101° 32′ W. 14–X–'04. 84° F.

300–0 fms.: 100 loricæ counted; 114 identified; 38 spp.:

TPS. radix 9%; COD. acuta 1, apicata 1, cuspidata 1, tropica 4; CDNR. australis 1; STEN. nivalis 5; CDLLPS. americana 36, meridionalis 9, minor 2, robusta 1, turgescens 2, turgida 1; CLIM. scalaria 1; CYTT. acutiformis 1; FAV. panamensis 1; EPIP. deflexa 7, pacifica 3, undella 4; PET. capsa 1; RHAB. amor 1, cuspidata 2, inflata 1, poculum 1, quantula 1, spiralis 1; XPS. dicymatica 2, tenuirostris 2; DICT. occidentalis 1, polygonata 1, reticulata 1; STEEN. robusta 1, steenstrupii 1; EUT. tenuis 2, tubiformis 1; DAT. stramonium 1; SALP. acuminata 2, faurei 1.

4596. 16° 47′ N.; 100° 27′ W. 14–X–'04. 84° F.

Surface: 100 loricæ counted; 119 identified; 17 spp.:

TPS. radix 1%; STEN. nivalis 1; CDLLPS. americana 72, meridionalis 6, minor 1; FAV. panamensis 1; EPIP. deflexa 2, undella 1; EPIOR. acuta 1; RHAB. cornucopia 2, poculum 1, quantula 1, spiralis 1; PROP. claparèdei 1; AMPH. quadrilineata 9; EUT. elongatus 2, tenuis 1, tubulosus 3.

4598. 15° 58′ N.; 98° 13′ W. 15–X–'04. 84° F.

300–0 fms.: 100 loricæ counted; 102 identified; 31 spp.:

TPS. karajacensis 1%, sacculus 1; COD. cuspidata 2; CDLLPS. americana 9, meridionalis 4; CYTT. acutiformis 1, eucecryphalus 1, longa 1; FAV. panamensis 1; EPIP. constricta 2, pacifica 18; EPIOR. healdi 3; PROTORH. simplex 1; RHAB. cuspidata 7, inflata 1, poculum 23, quantula 3; PAR. caudata 1; XPS. dicymatica 2, heroica 1, tenuirostris 2; PROP. cuspidata 1, fastigata 1, ovata 1, perpusilla 2; DICT. mexicana 1, pacifica 1, reticulata 5; DAD. acutiformis 1, bulbosa 1, curta 1, ganymedes 1.

4600. 15° 36′ N.; 97° 0′ W. 15–X–'04. 82° F.

Surface: 100 loricæ counted; 105 identified; 16 spp.:

STEN. nivalis 1%; CDLLPS. americana 7, robusta 1; EPIP. constricta 3, undella 3; EPIOR. acuta 2; PROTORH. simplex 2; RHAB. amor 2, cornucopia 1, cuspidata 8, poculum 7, quantula 46; AMPH. quadrilineata 11; EUT. elongatus 3, pinguis 5, turgescens 1.

4604. 12° 21′ N.; 92° 13′ W. 17–X–'04. 84° F.

Surface: 100 loricæ counted; 116 identified; 11 spp.:

CDLLPS. americana 3%, meridionalis 1; EPIP. blanda 1, constricta 4, deflexa 6, undella 20; RHAB. amor 11, conica 2, quantula 46, striata 3; UND. hemispherica 3.

4605. 12° 21′ N.; 92° 13′ W. 17–X–'04. 85° F.

300–0 fms.: 100 loricæ counted; 117 identified; 32 spp.:

COD. cuspidata 1%; CDLLPS. americana 1, meridionalis 9, minor 11, turgescens 1; COX. laciniosa 1; CYTT. acutiformis 1; EPIP. blanda 2, constricta 9, deflexa 10, pacifica 3, undella 16; RHAB. amor 2, conica 20, cuspidata 6, quantula 5, striata 2; PAR. aciculifera 1, aculeata 2; XYST. treforti 2; XPS. hastata 2; PROP. claparèdei 1, perpusilla 2; UND. globosa 1, hemispherica 1; DICT. pacifica 1; DAD. acutiformis 1; ORM. cornucopia 1; STEL. fenestrata 1; DAT. stramonium 1; SALP. acuminata 1, subconica 1.

4607. 12° 0′ N.; 91° 30′ W. 17–X–'04. 83° F.

Surface: 100 loricæ counted; 100 identified; 17 spp.:

CDLLPS. americana 1%, meridionalis 1; COX. laciniosa 1; EPIP. blanda 1, constricta 2, deflexa 11, pacifica 2, undella 22; RHAB. amor 3, conica 6, inflata 4, poculum 1, quantula 4, striata 31; UND. hemispherica 11; AMPL. monocollaria 1; DICT. mexicana 1.

Panamic Area. Stations 4609–4644

4609. 11° 5′ N.; 89° 35′ W. 18–X–'04. 81° F.

300–0 fms.: 100 loricæ counted; 100 identified; 31 spp.:

TPS. beroidea 1%; COD. cuspidata 2; CDLLPS. biedermanni 2, meridionalis 4, minor 7; CYTT. longa 1; EPIP. blanda 4, deflexa 7, pacifica 1, undella 8; RHAB. amor 4, conica 6, cuspidata 1, poculum 1, quantula 12, striata 15; PAR. gigantea 1; XYST. treforti 6; XPS. cymatica 1, dahli 1, ornata 2, tenuirostris 1, tropica 1; PROP. perpusilla 2; UND. hemispherica 3, ostenfeldi 1; DICT. mexicana 1, reticulata 2; AMPH. quadrilineata 2; STEL. fenestrata 1; DAT. stramonium 1.

4611. 10° 33′ N.; 88° 30′ W. 18–X–°04. 78° F.

Surface: 100 loricæ counted; 103 identified; 25 spp.:

EPIP. deflexa 1%, pacifica 4; EPIOR. acuta 1, healdi 3; RHAB. amor 1, inflata 2, quantula 16, striata 9; RDPS. triton 3; XYST. treforti 2; PROP. claparèdei 8, globosa 2, perpusilla 2; DICT. mexicana 1, occidentalis 1, reticulata 9; AMPH. quadrilineata 19; DAD. bulbosa 1, ganymedes 1; EUT. elongatus 4, lusus-undæ 1, medius 1, perminutus 1, tenuis 1, turgescens 11.

4613. 9° 45′ N.; 86° 20′ W. 19–X–'04. 80° F.

300–0 fms.: 100 loricæ counted; 105 identified; 37 spp.:

COD. cuspidata 1%; CDNR. australis 1; CDLLPS. meridionalis 5, minor 7, turgescens 2; COX. fabricatrix 1; CYTT. eucecryphalus 1, longa 6; EPIP. undella 1; EPIOR. acuta 13, healdi 13; PROTORH. simplex 1; RHAB. elegans 2, quantula 3, spiralis 5; PAR. gigantea 1; XYST. treforti 11; XPS. cyclas 1, cymatica 1, hastata 1, ornata 5, pulchra 2, tropica 1; PROP. ovata 1, perpusilla 1, prælonga 1; DICT. reticulata 2; STEEN. steenstrupii 2; AMPH. quadrilineata 1; DAD. acutiformis 2, bulbosa 1, curta 1, ganymedes 1; STEL. fenestrata 1; EUT. tenuis 3; SALP. subconica 1; SALPGC. unguiculata 2.

4615. 9° 7′ N.; 85° 11′ W. 19–X–'04. 80° F.

Surface: 50 loricæ counted; 63 identified; 19 spp.:

EPIP. blanda 1%, deflexa 1, undella 16; RHAB. conica 5, cuspidata 1, elegans 2, inflata 8, poculum 2, quantula 8, spiralis 15, striata 1; PAR. aculeata 1; XPS. heroica 2; PROP. claparèdei 1, perpusilla 1; DICT. lepida 24, polygonata 1, reticulata 16; DAD. ganymedes 4.

4617. 7° 45′ N.; 82° 25′ W. 20–X–'04. 78° F.

Surface: 50 loricæ counted; 52 identified; 15 spp.:

EPIP. deflexa 2%, pacifica 4, undella 20; RHAB. amor 14, poculum 6, quantula 31, spiralis 1; RDPS. triton 2; UND. hemispherica 2; DICT. duplex 4, occidentalis 1, polygonata 1, reticulata 8; STEEN, steenstrupii 4; EUT. elongatus 2.

300–0 fms.: 68 loricæ counted; 72 identified; 32 spp.:

TPS. radix 1%; CDLLPS. americana 3, meridionalis 3, minor 2, speciosa 1, turgescens 2; CYTT. acutiformis 5, longa 3; EPIP. deflexa

6, pacifica 3, undella 3; RHAB. amor 1, cuspidata 1, quantula 9, spiralis 12; RDPS. triton 2; XYST. treforti 1; XPS. dahli 2, heroica 8; PROP. claparèdei 1, parva 5; UND. hemispherica 1; DICT. pacifica 1, reticulata 7; DAD. acutiformis 1, ganymedes 3; EUT. elongatus 1, tenuis 5; SALP. acuminata 3, secata 3, subconica 5; RHABDS. cuneolata 1.

4619. 7° 15′ N.; 82° 8′ W. 20–X–'04. 79° F.

Surface: 50 loricæ counted; 53 identified; 17 spp.:

CDLLPS. americana 2%, meridionalis 2; CLIM. scalaroides 1; EPIP. undella 2; RHAB. amor 18, cornucopia 2, cuspidata 2, inflata 2, poculum 6, quantula 23, spiralis 1; RDPS. triton 2; DICT. reticulata 12; STEEN. steenstrupii 6; AMPH. minor 1, quadrilineata 18; EUT. elongatus 4.

4621. 6° 36′ N.; 81° 44′ W. 21–X–'04. 79° F.

300–0 fms.: 50 loricæ counted; 60 identified; 6 spp.:

COD. cuspidata 4%; FAV. panamensis 1; EPIOR. acuta 16; RHAB. amor 12; PROP. claparèdei 2; DICT. reticulata 66.

4624. 6° 58′ N.; 80° 46′ W. 21–X–'04. 79° F.

Surface: 100 loricæ counted; 101 identified; 10 spp.:

TPS. beroidea 8%, radix 5, schotti 2; STEN. nivalis 22; CDLLPS. americana 38, minor 1; RHAB. amor 1, cornucopia 1, cuspidata 21; EUT. tenuis 2.

4627. 7° 21′ N.; 79° 55′ W. 2–XI–'04. 81.5° F.

Surface: 100 loricæ counted; 107 identified; 13 spp.:

TPS. beroidea 26%, plagiostoma 9, radix 5; STEN. nivalis 6; CDLLPS. americana 17; CLIM. scalaria 1; FAV. panamensis 1; RHAB. amor 1, conica 2, quantula 23; AMPH. quadrilineata 2; AMPHS. acuta 1; EUT. tenuis 6.

4630. 6° 53′ N.; 81° 42′ W. 3–XI–'04. 81° F.

Surface: 25 loricæ counted; 25 identified; 3 spp.:

RHAB. quantula 88%, striata 8; DICT. reticulata 4.

4631. 6° 26′ N.; 81° 49′ W. 3–XI–'04. 82° F.

Surface: 100 loricæ counted; 100 identified; 11 spp.:

TPS. radix 1%; RHAB. quantula 62, striata 6; RDPS. triton 2; PROP. claparèdei 1; UND. hemispherica 1; DICT. reticulata 2; STEEN. robusta 1, steenstrupii 1; AMPH. quadrilineata 1; EUT. elongatus 22.

4634. 4° 35′ N.; 83° 32′ W. 4–XI–'04. 80° F.

300–0 fms.: 100 loricæ counted; 117 identified; 49 spp.:

COD. cuspidata 1%; CDNR. oceanica 4; CDLLPS. minor 21, parva 1; CLIM. scalaria 1; CYTT. acutiformis 1; EPIOR. acuta 1; ACAN. conicoides 1, lata 1, obtusa 1; RHAB. amor 1; RDPS. triton 3; PAR. aciculifera 1, aculeata 5, invaginata 1, prætenuis 2; XYST. minuscula 3, treforti 6; XPS. cyclas 4, favata 1, heroica 3, pinnata 1, pulchra 3, tropica 6; PROP. claparèdei 2, cuspidata 2, parva 3; UDPS. pacifica 1; DICT. pacifica 1, reticulata 1, spinosa 1; STEEN. gracilis 1, steenstrupii 4; AMPHS. lævis 1; DAD. bulbosa 1; ORM. apsteini 1, cornucopia 2; STEL. fenestrata 1; EUT. apertus 1, colligatus 1, elongatus 8, fraknóii 2, lusus-undæ 1, tenuis 2; DAT. stramonium 1; SALP. acuminata 2, faurei 2, jugosa 1, subconica 1.

4635. 3° 52′ N.; 84° 14′ W. 4–XI–'04. 79°F.

Surface: 50 loricæ counted; 57 identified; 17 spp.:

CDNR. australis 2%; CDLLPS. minor 1; EPIP. pacifica 2; RHAB. amor 8, minuscula 6; PAR. prætenuis 1; XYST. treforti 2; DICT. reticulata 10; STEEN. gracilis 1; steenstrupii 16; AMPH. quadrilineata 8; EUT. colligatus 12, elongatus 28, stramentus 2, tenuis 2; SALP. acuminata 2, subconica 1.

4637. 1° 31′ N.; 86° 32′ W. 5–XI–'04. 76° F.

300–0 fms.: 100 loricæ counted; 121 identified; 44 spp.:

COD. apicata 4%; CDLLPS. minor 1; CLIM. scalaria 1; CYTT. longa 2; POR. curtus 1; EPIP. blanda 2, pacifica 5; ACAN. obtusa 1; PROTORH. simplex 1; RHAB. amor 1, cornucopia 10, poculum 11, quantula 16; RDPS. triton 1; PAR. aciculifera 1, aculeata 1, gigantea 2, invaginata 2; XYST. minuscula 1, treforti 4; XPS. cyclas 1, favata 3, hastata 1; XPS. ornata 1, pulchra 1, tenuirostris 1, tropica 1; PROP. cuspidata 2, globosa 11, ovata 1, parva 2, perpusilla 4; UDPS.

pacifica 1; DICT. reticulata 10; STEEN. steenstrupii 1; AMPH. quadrilineata 1; AMPHS. lævis 1; DAD. acutiformis 4, ganymedes 1; ORM. cornucopia 1; STEL. fenestrata 1; EUT. colligatus 1, elongatus 3; SALP. acuminata 1.

4638. 0° 27′ N.; 87° 13′ W. 6–XI–'04. 75° F.

Surface: 50 loricæ counted; 51 identified; 19 spp.:

COD. apicata 2%, cuspidata 2, tropica 2; CDLLPS. minor 2; CLIM. scalaroides 2; EPIOR. acuta 2; RHAB. amor 4, poculum 20, quantula 12, spiralis 2; RDPS. intermedia 4; DICT. reticulata 26; AMPH. quadrilineata 2; DAD. ganymedes 6; EUT. apertus 1, colligatus 4, elongatus 4, stramentus 2, tenuis 2.

300–0 fms.: 36 loricæ counted; 39 identified; 21 spp.:

COD. apicata 3%; CDLLPS. minor 6; COX. laciniosa 3; CYTT. acutiformis 3, longa 11; POR. curtus 6; ACAN. obtusa 3; RHAB. poculum 8, spiralis 3; PAR. gigantea 3; XYST. treforti 6; PROP. claparèdei 8, globosa 1, parva 7; DICT. reticulata 17; EUT. colligatus 3, tenuis 3; DAT. stramonium 3; SALP. acuminata 6, glockentogeri 3, ricta 1.

4639. 0° 4′ S.; 87° 39′ W. 6–XI–'04. 76° F.

Surface: 100 loricæ counted; 103 identified; 19 spp.:

COD. apicata 1%; EPIP. pacifica 4; EPIOR. acuta 9, curta 1; PROTORH. simplex 1; RHAB. amor 2, poculum 57, quantula 5, striata 1; XYST. treforti 3; PROP. claparèdei 1, perpusilla 1; DICT. reticulata 11; STEEN. steenstrupii 1; DAD. ganymedes 1; EUT. apertus 1, elongatus 1, tenuis 1; SALP. acuminata 1.

4640. 0° 39′ S.; 88° 11′ W. 6–XI–'04. 75° F.

Surface: 133 loricæ counted; 141 identified; 32 spp.:

COD. acuta 1%, acutula 1, apicata 2, cuspidata 1; POR. apicatus 1, curtus 1; EPIP. deflexa 1, pacifica 2; EPIOR. acuta 17, curta 1, healdi 1; PROTORH. simplex 1; RHAB. amor 1, cornucopia 1, inflata 1, poculum 10, quantula 1, spiralis 1; PROP. claparèdei 2, perpusilla 2; DICT. occidentalis 1, pacifica 1, reticulata 42; STEEN. robusta 1, steenstrupii 1; AMPH. quadrilineata 1; DAD. ganymedes 3; EUT. colligatus 1, elongatus 2, stramentus 1, tenuis 5, turgescens 1.

4644. 2° 13′ S.; 89° 42′ W. 7–XI–'04. 72° F.

Surface: 100 loricæ counted; 110 identified; 26 spp.:

EPIP. exquisita 1%, pacifica 9; EPIOR. acuta 52, curta 1, healdi 1; PROTORH. curta 1, simplex 1; RHAB. amor 1, poculum 18; RDPS. triton 1; PROP. ovata 1, perpusilla 1, tenuis 1; DICT. reticulata 6; STEEN. robusta 1, steenstrupii 1; AMPH. quadrilineata 2; DAD. acutiformis 1, bulbosa 1, ganymedes 1; EUT. colligatus 3, elongatus 3, lusus-undæ 1, stramentus 1, tenuis 4, turgescens 1.

Peruvian Current. Stations 4646–4678

4646. 4° 1′ S.; 89° 16′ W. 8–XI–'04. 72° F.

300–0 fms.: 65 loricæ counted; 65 identified; 28 spp.:

CDNR. mucronata 3%; CDLLPS. meridionalis 5, minor 6; COX. laciniosa 2; EPIP. exquisita 3, pacifica 6; EPIOR. acuta 7; ACAN. obtusa 2; RHAB. inflata 2, poculum 7; PAR. aciculifera 3, attenuata 1, difficilis 1, humerosa 2, invaginata 2, perpusilla 4, prætenuis 5; XPS. armata 3, favata 3, hastata 7, tropica 2; PROP. ovata 2, prælonga 5; DICT. reticulata 18; STEEN. steenstrupii 2; STEL. fenestrata 2; EUT. elongatus 2, tenuis 2.

4647. 4° 33′ S.; 87° 42′ W. 9–XI–'04. 70° F.

800–0 fms.: 15 loricæ counted: 18 identified; 16 spp.:

CDNR. mucronata 7%; CDLLPS. minor 7, pura 13; CYTT. longa 6: EPIOR. acuta 7; RHAB. inflata 7, poculum 7; PAR. difficilis 1; PAR. invaginata 13, prætenuis 1; XPS. armata 7, cyclas 7; PROP. ovata 7, prælonga 7; DICT. reticulata 1; DAD. acutiformis 7.

4648. 4° 43′ S.; 87° 7′ W. 9–XI–'04. 71° F.

Surface: 25 loricæ counted; 28 identified; 7 spp.:

EPIOR. curta 20%; RHAB. indica 8; XYST. minuscula 22, treforti 50; PROP. prælonga 1; AMPH. quadrilineata 1; DAD. bulbosa 1.

300–0 fms.: 100 loricæ counted; 111 identified; 38 spp.:

CDLLPS. contracta 1%; CLIM. scalaria 1; POR. curtus 1; EPIP. exquisita 5; EPIOR. acuta 17, curta 2; ACAN. obtusa 1; RHAB. indica 1, inflata 4; RDPS. triton 5; PAR. aciculifera 5, caudata 2,

difficilis 6, humerosa 1, invaginata 3, messinensis 1; XYST. minuscula 2, treforti 5; XPS. cymatica 1, hastata 5, heroica 5, pulchra 3, tropica 3; PROP. claparèdei 3, cuspidata 1, parva 1, perpusilla 1, prælonga 4; DICT. pacifica 1; DAD. acutiformis 4, bulbosa 1; ORM. cornucopia 1, hæckeli 2, schmidti 1, schweyeri 1; EUT. elongatus 3, fraknóii 5; SALPGC. exilis 2.

4649. 5° 17′ S.; 85° 19′ W. 10–XI–'04. 70° F.

800–0 fms.: 2 loricæ counted; 2 identified; 1 sp.

No Tintinnoinea, except for 2 broken Epiorella ralumensis. 100%.

4650. 5° 22′ S.; 84° 39′ W. 10–XI–'04. 71° F.

Surface: 50 loricæ counted; 50 identified; 8 spp.:

COX. laciniosa 2%; EPIOR. acuta 80, curta 4; PROTORH. curta 2; XYST. treforti 2; AMPH. quadrilineata 4; DAD. bulbosa 2, ganymedes 4.

300–0 fms.: 100 loricæ counted; 116 identified; 41 spp.:

COD. cuspidata 1%; CDNR. mucronata 1; CDLLPS. contracta 1, minor 1; CYTT. longa 1; EPIOR. curta 1, healdi 48; CRAT. urceolata 1; PROTORH. curta 1, simplex 1; RHAB. poculum 1; RDPS. intermedia 1, triton 3; PAR. caudata 4, difficilis 2, invaginata 1; XYST. minuscula 2, treforti 3; XPS. armata 3, cyclas 1; XPS. cymatica 1, dahli 1, favata 1, hastata 2, ornata 6, pulchra 1, tropica 1; PROP. claparèdei 1, ovata 1, perpusilla 3, prælonga 1; UDPS. pacifica 1, tricollaria 1; DICT. reticulata 1; AMPH. quadrilineata 1; DAD. bulbosa 9, ganymedes 1; ORM. cornucopia 2; STEL. simplex 1; EUT. tenuis 1; EPIOR. bellissima 1. Salpa stomach: EPIOR. healdi, 14; CRAT. armilla, 6; ACAN. obtusa, 6; DAD. bulbosa, 5.

4651. 5° 41′ S.; 82° 59′ W. 11–XI–'04. 66° F.

800–0 fms.: 30 loricæ counted; 30 identified; 16 spp.:

CDLLPS. contracta 3%; EPIOR. acuta 10; RHAB. inflata 10, spiralis 3; PAR. aciculifera 3, caudata 13, difficilis 7, gigantea 7, invaginata 7; XPS. dahli 7; PROP. claparèdei 7, perpusilla 7, prælonga 7; DICT. lepida 3; DAD. acutiformis 3; ORM. cornucopia 3.

4652. 5° 44′ S.; 82° 39′ W. 11–XI–'04. 66° F.

100–0 fms.: 1 lorica counted; 1 identified; 1 sp.:

PAR. caudata 100%.

200–0 fms.: 3 loricæ counted; 3 identified; 3 spp.:

CDLLPS. contracta 33%; PAR. invaginata 33; DAD. bulbosa 33.

400–0 fms.: 12 loricæ counted; 12 identified; 9 spp.:

EPIOR. acuta 8%; RHAB. inflata 8, spiralis 8; PAR. aciculifera 8, caudata 24; PROP. claparèdei 16; DAD. acutiformis 8, bulbosa 8; ORM. cornucopia 8.

4655. 5° 57′ S.; 80° 50′ W. 12–XI–'04. 65° F.

Surface: 1 lorica counted; 1 identified; 1 sp.:

EPIOR. curta 100%, 1 lorica only on 5 slides.

400–0 fms.: 25 loricæ counted; 27 identified; 13 spp.:

CDLLPS. contracta 48%; EPIOR. acuta 4, curta 1, healdi 1; PROTORH. simplex 4; PAR. aculeata 8, difficilis 8, invaginata 4; PROP. claparèdei 4, perpusilla 8; UND. hyalina 4; AMPHS. acantharus 1; DAD. acutiformis 8.

4657. 7° 12′ S.; 84° 9′ W., 13–XI–'04. 69° F.

Surface: No Tintinnoinea found.

300–0 fms.: 16 loricæ counted; 16 identified; 5 spp.:

CDLLPS. minor 6%; EPIOR. acuta 52; RHAB. poculum 6; DICT. pacifica 6; EUT. elongatus 30.

4659. 8° 54′ S.; 86° 5′ W. 14–XI–'04. 69° F.

Surface: 100 loricæ counted; 111 identified; 20 spp.:

CDNR. lata 1%, mucronata 1; CDLLPS. minor 3; EPIOR. acuta 14, curta 2; PET. foli 1; PROTORH. striatura 1; RDPS. triton 46; PAR. elongata 1; XYST. minuscula 10, treforti 2; XPS. brandti 1; DICT. lepida 1; AMPH. quadrilineata 6; DAD. bulbosa 1; EUT. apertus 1, elongatus 4, lusus-undæ 1, medius 3, tenuis 7.

300–0 fms.: [125 loricæ counted; 144 identified; 28 spp.:

COD. cuspidata 2%; CDNR. mucronata 1; CDLLPS. minor 18; CYTT. longa 1; POR. curtus 1; EPIOR. curta 9; PET. foli 2; RHAB. cuspidata 1; RDPS. triton 18; PAR. humerosa 1; XYST. minuscula 3; XPS. hastata 1, tropica 1; PROP. claparèdei 3, perpusilla 9; DICT. lepida 2, pacifica 1, reticulata 1; AMPH. quadrilineata 2; DAD. acutiformis 1; EUT. elongatus 6, lusus-undæ 8, macilentus 1, tenuis 6, turgescens 1; SALP. acuminata 2, glockentögeri 2, subconica 2.

4661. 10° 17′ S.; 88° 2′ W. 15–XI–'04. 69° F.

Surface: 20 loricæ counted; 22 identified; 9 spp.:

CLIM. scalaria 5%; EPIOR. acuta 5; RHAB. spiralis 1; RDPS. triton 35; DICT. duplex 10, polygonata 1, reticulata 20; EUT. elongatus 20, perminutus 5.

300–0 fms.: [25 loricæ counted; 31 identified; 14 spp.:

COD. cuspidata 1%; CDNR. cistellula 1, mucronata 1; EPIOR. acuta 24; PET. foli 1; RHAB. cuspidata 5, spiralis 3; RDPS. triton 16; PROP. claparèdei 1, prælonga 8; DICT. duplex 24, lepida 1, reticulata 4; EUT. elongatus 16.

[4662. 11° 13′ S.; 89° 35′ W. 16–XI–'04. 69° F.

800–0 fms.: 100 loricæ counted; 112 identified; 37 spp.:

COD. cuspidata 3%, galea 2; CDNR. mucronata 1; CDLLPS. minor 4; CYTT. cassis 1, longa 4, magna 1; EPIOR. acuta 5; PET. foli 1; RHAB. conica 2, cuspidata 5, exilis 1, inflata 1, striata 1; RDPS. triton 8; PAR. aciculifera 1, humerosa 1, messinensis 3; XYST. minuscula 7, treforti 2; XPS. favata 2, inæqualis 3, ornata 4, pulchra 3, tropica 4; PROP. ostenfeldi 1, perpusilla 5; UND. ostenfeldi 1; DICT. pacifica 1, reticulata 21; ORM. hæckeli 2, schmidti 3; PROST. phialia 1; EUT. elongatus 1, perminutus 1, tenuis 2; SALP. acuminata 3.

4663. 11° 20′ S.; 88° 52′ W. 16–XI–'04. 69° F.

Surface: 5 loricæ counted; 5 identified; 5 spp.:

COD. acuta 20%; CDNR. mucronata 20; DICT. duplex 20, mexicana 20, reticulata 20.

300–0 fms.: 25 loricæ counted; 25 identified; 12 spp.:

CDNR. mucronata 4%; CYTT. longa 4; EPIOR. acuta 8; RHAB. cuspidata 16, spiralis 4; XPS. favata 4; PROP. claparèdei 4, tenuis 12; DICT. duplex 8, polygonata 8, reticulata 24; ORM. schmidti 4.

Salpa stomach: FAV. panamensis 3; CRAT. urceolata 3; ACAN. obtusa 3; PROTORH. curta 3; RHAB. exilis 3; DICT. reticulata 3, tiara 3; EUT. apertus 3.

4664. 11° 30′ S.; 87° 19′ W. 17–XI–'04. 68° F.

Surface: 20 loricæ counted; 21 identified; 11 spp.:

EPIOR. acuta 15%; PET. foli 5; RHAB. conica 1, cuspidata 7, spiralis 6; RDPS. triton 20; XYST. minuscula 12, treforti 13; DICT. pacifica 5, polygonata 5, reticulata 5.

300–0 fms.: 50 loricæ counted; 53 identified; 23 spp.:

COD. acuta 6%; CLIM. scalaria 2; CYTT. longa 6; EPIOR. healdi 10; CRAT. urceolata 2; PET. foli 4; RHAB. conica 1, cuspidata 6, inflata 4, spiralis 4; RDPS. triton 20; PAR. aciculifera 2, attenuata 4; XPS. favata 2, ornata 2, pulchra 2, tropica 2; PROP. claparèdei 2, perpusilla 4; DICT. reticulata 10; STEL. fenestrata 1; SALP. acuminata 2, curta 1.

Salpa stomachs, 3 examined: EPIOR. healdi 9; CRAT. urceolata 1; ACAN. minutissima 1, obtusa 4; RHAB. conica 2; AMPH. minor 1; DAD. ganymedes 3; SALP. curta 1.

4665. 11° 45′ S.; 86° 5′ W. 17–XI–'04. 68° F.

Surface: 25 loricæ counted; 25 identified; 12 spp.:

COD. acuta 4%; CYTT. longa 4; POR. curtus 4; EPIOR. acuta 8; ACAN. minutissima 4; RDPS. triton 36; XYST. minuscula 10, treforti 6; DICT. mitra 4; AMPH. quadrilineata 4; EUT. elongatus 8, tenuis 8.

300–0 fms.: 100 loricæ counted; 110 identified; 36 spp.:

COD. acuta 3%; CDNR. mucronata 1; CDLLPS. minor 1; COX. fabricatrix 1, fasciata 1; CLIM. scalaria 1; CYTT. acutiformis 1, longa 4; EPIOR. acuta 2; PET. foli 4; PROTORH. striatura 1; RHAB. chiliensis 1, inflata 6, spiralis 1; RDPS. triton 20; PAR. difficilis 9; XYST. minuscula 3, treforti 2; XPS. tropica 1; PROP. claparèdei 2,

perpusilla 5, prælonga 1; DICT. duplex 1, lata 1, mitra 1, pacifica 1, polygonata 1, reticulata 8; STEL. fenestrata 1; EUT. apertus 1, brandti 1, elongatus 6, fraknóii 1, tenuis 14, turgescens 1; EPICR. prismatica 1.

4666. 11° 55′ S.; 84° 20′ W. 18–XI–'04. 67° F.

Surface: 100 loricæ counted; 101 identified; 19 spp.:

CDNR. lata 1%; COX. laciniosa 1; CLIM. scalaria 11; CYTT. longa 1; EPIP. blanda 2; EPIOR. acuta 49; ACAN. minutissima 1; PROTORH. simplex 3, striatura 2; RHAB. inflata 4; DICT. lepida 4, minor 1, tiara 1; AMPH. quadrilineata 1; DAD. acutiformis 1, bulbosa 15; EUT. elongatus 1, fraknóii 1, tenuis 2.

800–0 fms.: 100 loricæ counted; 104 identified; 27 spp.:

COD. acuta 6%, galea 1; CDLLPS. minor 5; CLIM. scalaria 1; CYTT. longa 2; POR. curtus 1; EPIOR. acuta 3, healdi 3; ACAN. minutissima 4; PET. foli 25; RHAB. inflata 8, spiralis 2; RDPS. triton 5; XYST. minuscula 1; XPS. krämeri 1, tropica 1; PROP. claparèdei 1, parva 3, prælonga 2; UND. pistillum 1; DICT. lepida 1, minor 10, pacifica 1, reticulata 6; DAD. acutiformis 4; EUT. elongatus 3, tenuis 4.

4667. 11° 59′ S.; 83° 40′ W. 18–XI–'04. 68° F.

Surface: 8 loricæ counted; 8 identified; 6 spp.:

CLIM. scalaria 13%; EPIOR. acuta 25, healdi 25; PROTORH. simplex 13; XYST. treforti 12; PROP. perpusilla 12.

300–0 fms.: 100 loricæ counted; 105 identified; 37 spp.:

COD. acuta 8%, cuspidata 1; CDNR. cistellula 1, mucronata 1; CDLLPS. contracta 1, minor 1; CLIM. scalaria 1; CYTT. longa 3; POR. curtus 1; EPIP. blanda 1; EPIOR. healdi 36; PET. foli 5; PROTORH. simplex 1; RHAB. cuspidata 1, hebe 1, inflata 5, spiralis 1, striata 1; RDPS. triton 3; PAR. aciculifera 1; XYST. minuscula 2, treforti 1; XPS. pulchra 1, tropica 1; PROP. claparèdei 1, parva 1; DICT. lepida 8, pacifica 1; DAD. acutiformis 4, bulbosa 1; EUT. elongatus 2, fraknóii 2, lusus-undæ 1, tenuis 2; DAT. stramonium 1; SALP. acuminata 1, subconica 1.

4668. 12° 9′ S.; 81° 45′ W. 19–XI–'04. 67° F.

300–0 fms.: 50 loricæ counted; 50 identified; 12 spp.:

COD. acuta 6%; CDLLPS. minor 2; EPIOR. acuta 5; PET. foli 2; RHAB. cuspidata 2, inflata 46, striata 4; XYST. minuscula 17; PROP. perpusilla 2; DICT. lepida 2; DAD. acutiformis 4; EUT. elongatus 8.

4669. 12° 12′ S.; 80° 25′ W. 19–XI–'04. 67° F.

Surface: 100 loricæ counted; 103 identified; 9 spp.:

CYTT. eucecryphalus 1%; EPIP. blanda 3; EPIOR. acuta 93, curta 1, healdi 1; PROTORH. simplex 1; XYST. minuscula 1, treforti 1; DAD. bulbosa 1.

300–0 fms.: 100 loricæ counted; 114 identified; 28 spp.:

COD. acuta 3%; CDNR. mucronata 3; CDLLPS. contracta 3, minor 3; CYTT. acutiformis 1, eucecryphalus 1, longa 1; EPIP. blanda 1; EPIOR. curta 2, healdi 36; PET. foli 4; RHAB. cuspidata 1, inflata 2; RDPS. triton 2; PAR. aciculifera 2, caudata 2, messinensis 1; XYST. treforti 5; XPS. pulchra 1; PROP. claparèdei 1, perpusilla 15; DICT. lepida 1, reticulata 7, tiara 4; DAD. acutiformis 4, bulbosa 6; EUT. apertus 1, elongatus 1.

4670. 12° 8′ S.; 79° 2′ W. 20–XI–'04. 66° F.

800–0 fms.: 50 loricæ counted; 53 identified; 21 spp.:

COD. acuta 6%; CDLLPS. contracta 22, minor 2; EPIOR. acuta 2, curta 1, healdi 14; PROTORH. simplex 2; RHAB. chiliensis 2, conica 4; PAR. aciculifera 2, attenuata 2, caudata 2, difficilis 4; XYST. minuscula 2; PROP. pentagona 4, perpusilla 10; UDPS. pacifica 2; DICT. mitra 2; AMPH. quadrilineata 2; DAD. acutiformis 12, bulbosa 2.

4671. 12° 6′ S.; 78° 28′ W. 29–XI–'04. 66° F.

Surface: 100 loricæ counted; 111 identified; 14 spp.:

COD. apicata 1%; EPIOR. acuta 1, curta 1, healdi 36; PROTORH. simplex 2; XYST. minuscula 3; DICT. duplex 17, lepida 1, reticulata 32; AMPH. quadrilineata 2; DAD. ganymedes 1; EUT. medius 2, tenuis 1, tubulosus 1.

300–0 fms.: 100 loricæ counted; 103 identified; 27 spp.:

COD. acuta 1%; CDNR. mucronata 1; CDLLPS. minor 3; CYTT. acutiformis 1; EPIOR. curta 2, healdi 26; ACAN. conicoides 1, lata 1; PET. foli 1; PROTORH. simplex 2; RHAB. amor 1, cuspidata 1; XYST. minuscula 2; XPS. favata 1, heroica 1; PROP. claparèdei 1, parva 4, perpusilla 9; DICT. duplex 8, lepida 1, mitra 2, reticulata 16, tiara 5; AMPH. quadrilineata 1; DAD. acutiformis 1, bulbosa 7; EUT. elongatus 2.

4673. 12° 30′ S.; 77° 49′ W. 21–XI–'04. 67° F.

Surface: 100 loricæ counted; 101 identified; 3 spp.:

HELIC. longa 99%; EPIOR. healdi 1; AMPH. quadrilineata 1.

300–0 fms.: 100 loricæ counted; 105 identified; 22 spp.:

CDLLPS. contracta 5%, minor 3; CLIM. scalaria 1; HELIC. longa 58; EPIOR. acuta 1, curta 1, healdi 14; RHAB. cuspidata 1; RDPS. longicaulis 1; XPS. paradoxa 1; PROP. claparèdei 1, globosa 1, parva 1, perpusilla 3, prælonga 3; DICT. lepida 2, mitra 1, tiara 2; DAD. acutiformis 1, bulbosa 2; EUT. elongatus 1; EPICR. prismatica 1.

4675. 12° 54′ S.; 78° 33′ W. 22–XI–'04. 68° F.

Surface: 50 loricæ counted; 50 identified; 10 spp.:

POR. curtus 1%; EPIP. blanda 2; EPIOR. acuta 2; PROTORH. simplex 2; RHAB. striata 2; XYST. minuscula 60; DICT. duplex 13, lepida 2, reticulata 10, tiara 6.

300–0 fms.: 100 loricæ counted; 119 identified; 50 spp.:

COD. acuta 1%; CDLLPS. contracta 4, minor 3; HELIC. longa 3; CYTT. conica 1, longa 1; EPIP. sargassensis 2; EPIOR. curta 1, healdi 5; ACAN. minutissima 1; PET. foli 1; PROTORH. simplex 1; RHAB. cuspidata 4, exilis 2, henseni 1, inflata 1, striata 1; PAR. acuta 1, difficilis 1; XYST. minuscula 2, treforti 1; XPS. armata 1, brandti 1, favata 1, hastata 1, ornata 1, tropica 1; PROP. claparèdei 1, ovata 1, parva 1, pentagone 1, perpusilla 1, prælonga 1; UND. peruana 1; UDPS. pacifica 2; DICT. duplex 25, fenestrata 1, lata 1, lepida 1, mitra 1, reticulata 14, tiara 6; AMPH. quadrilineata 3; DAD. acutiformis 3, bulbosa 2, ganymedes 1; EUT. elongatus 5, rugosus 1, tubulosus 1; EPICR. bella 1.

4676. 14° 28′ S.; 81° 24′ W. 5–XII–'04. 69° F.

300–0 fms.: 100 loricæ counted; 284 identified; 43 spp.:

COD. amphorella 1%; CDNR. mucronata 1; CDLLPS. longa 1, minor 1; CLIM. scalaria 1; CYTT. acutiformis 1, longa 2; EPIP. blanda 1, exigua 2, sargassensis 1; EPIOR. acuta 2, curta 1, healdi 2; EPIC. nervosa 1; RHAB. cuspidata 1, inflata 60, striata 5; PAR. caudata 1, prætenuis 1; XYST. minuscula 4; XPS. armata 1, cymatica 1, krämeri 1, ornata 1, spicata 1, tropica 1; PROP. amphora 1, ellipsoida 1, globosa 1, parva 1; UND. hyalina 4, peruana 3; UDPS. pacifica 1; DICT. duplex 1, lepida 3, mitra 1, polygonata 1, reticulata 10, tiara 10; AMPH. quadrilineata 1; DAD. acutiformis 1; EUT. elongatus 1, tubulosus 1.

800–0 fms.: 50 loricæ counted; 54 identified; 17 spp.:

CLIM. scalaria 4%; CYTT. longa 2; EPIP. blanda 4; EPIOR. acuta 2, curta 1, healdi 2; RHAB. inflata 1, striata 53; XYST. minuscula 14; XPS. torta 2, tropica 2; DICT. duplex 1, polygonata 1, reticulata 2, tiara 2; EUT. elongatus 10, tubulosus 2.

4677. 14° 37′ S.; 81° 41′ W. 5–XII–'04. 68° F.

Surface: 25 loricæ counted; 28 identified; 10 spp.:

COD. acuta 1%; COX. laciniosa 4; EPIP. blanda 64; EPIOR. acuta 16, curta 1, healdi 1; EPIC. nervosa 4; DICT. reticulata 4; AMPH. quadrilineata 4; DAD. bulbosa 4.

4678. 16° 31′ S.; 85° 3′ W. 6–XII–'04. 68° F.

Surface: 100 loricæ counted; 106 identified; 32 spp.:

COD. elongata 1%; CDNR. lata 2; CDPS. ollula 8; CDLLPS. longa 1; CLIM. scalaria 1; CYTT. eucecryphalus 10, longus 3; EPIP. blanda 3, exigua 7; EPIOR. acuta 9; EPIC. nervosa 10; PROTORH. simplex 3; RHAB. lohmanni 4; RDPS. longicaulis 14; XPS. tropica 1; PROP. ellipsoida 1; UND. mammilata 1, peruana 1; DICT. dilatata 1, mitra 2, reticulata 1; STEEN. steenstrupii 1; AMPH. quadrilineata 1; DAD. acutiformis 1, ganymedes 1; EUT. birictus 2, elongatus 9, fraknóii 2, macilentus 2, tenuis 2, tubulosus 1; SALP. gracilis 1.

South Equatorial Drift. Stations 4679–4688

4679. 17° 26′ S.; 86° 46′ W. 7–XII–'04. 69° F.

300–0 fms.: 130 loricæ counted; 162 identified; 66 spp.:

COD. apicata 1%, galea 1; CDNR. australis 2, lata 1; CDLLPS. contracta 1, inflata 1, longa 5; CLIM. scalaria 4; CYTT. brandti 3, eucecryphalus 7, longa 2, magna 1; EPIP. blanda 1, exigua 4, sargassensis 5; EPIOR. acuta 1; EPIC. nervosa 4; PET. major 1; PROTORH. simplex 1; RHAB. cornucopia 1, elegans 1, inflata 4, lohmanni 2, valdestriata 1; RDPS. longicaulis 1, minima 13; PAR. caudata 1, difficilis 1, invaginata 1; XYST. treforti 1; XPS. armata 2, cymatica 3, favata 3, heroica 1, heros 1, inæqualis 1, krämeri 1, ornata 1, paradoxa 1, pulchra 4, tropica 7; PROP. amphora 1, biangulata 1, ellipsoida 2, globosa 2, perpusilla 1; UND. hyalina 3, parva 4, peruana 2; AMPL. monocollaria 1; UDPS. entzi 1, pacifica 1; DICT. mitra 2, reticulata 1; AMPH. quadrilineata 1; ODONT. serrulata 1; ORM. schmidti 1; STEL. simplex 1; EUT. birictus 1, elongatus 1, fraknóii 1, macilentus 1, tenuis 1; DAT. striata 1; SALP. acuminata 1, tuba 1.

4680. 17° 55′ S.; 87° 42′ W. 7–XII–'04. 68° F.

Surface: 100 loricæ counted; 107 identified; 23 spp.:

COD. pacifica 1%; CDNR. lata 7, mucronata 1; CDPS. ollula 15; CDLLPS. inflata 1; CYTT. eucecryphalus 8, longa 1; EPIP. exigua 5; EPIC. nervosa 3; PET. foli 1; RHAB. lohmanni 1; RDPS. minima 28; XPS. inæqualis 1, tropica 1; DICT. duplex 1, reticulata 1, tiara 1; STEEN. gracilis 1, steenstrupii 6; AMPH. quadrilineata 9; ORM. cornucopia 1; EUT. elongatus 10, macilentus 3.

4681. 18° 47′ S.; 89° 26′ W. 8–XII–'04. 68° F.

300–0 fms.: 100 loricæ counted; 315 identified; 77 spp.:

COD. acuta 1%, amphorella 2, apicata 2, diomedæ 1, galea 1; CDNR. australis 2, lata 2, mucronata 1; CDPS. ollula 2; CDLLPS. inflata 2, longa 12, minor 1; COX. laciniosa 1; CLIM. scalaria 1; CYTT. cassis 1, eucecryphalus 1, longa 1; EPIP. exigua 2, sargassensis 1; EPIOR. acuta 1; EPIC. nervosa 1; PET. foli 2, major 1; PROTORH. simplex 1; RHAB. exilis 1, lohmanni 1; RDPS. longicaulis 3, minima 7, triton 4; PAR. aciculifera 1, acuta 1, difficilis 1, inflata 1, messinensis 1; XYST. longicauda 1; XPS. armata 1, conicacauda 1, cymatica 1, favata 3, hastata 1, inæqualis 2, krämeri 1, paradoxa 1, tropica 4;

PROP. biangulata 1, ellipsoida 1, globosa 1, ovata 1, parva 1, perpusilla 1; UND. declivis 1, dilatata 1, hyalina 2, peruana 2, turgida 1; AMPL. occidentalis 1; UDPS. pacifica 1, tricollaria 1; DICT. dilatata 1, duplex 1, minor 1, pacifica 3, reticulata 4, spinosa 1, tiara 1; STEEN. gracilis 1; AMPH. quadrilineata 1; DAD. acutiformis 1; ORM. schmidti 1; STEL. fenestrata 1; EUT. birictus 1, elongatus 1, fraknóii 1, macilentus 1, tenuis 1; DAT. stramonium 1; SALPGC. undata 1.

800–0 fms.: 200 loricæ counted; 200 identified; 66 spp.:

COD. amphorella 3%, apicata 1, diomedæ 1, galea 1; CDNR. cistellula 3, lata 2; CDPS. ollula 2; CDLLPS. longa 4, pura 1, speciosa 4; COX. laciniosa 1; CLIM. scalaria 3; CYTT. cassis 1, eucecryphalus 1, longa 4, mucronata 2; POR. curtus 1; EPIP. exigua 1, sargassensis 2; EPIC. nervosa 1; ACAN. minutissima 1; PET. foli 2; PROTORH. simplex 1; RHAB. amor 1; RDPS. longicaulis 4, minima 5, triton 1; PAR. aciculifera 1, aculeata 1, caudata 1, inflata 1; XYST. longicauda 2, treforti 1; XPS. favata 2, heros 2, krämeri 1, paradoxa 1; PROP. amphora 1, ellipsoida 1, ovata 1, parva 1, perpusilla 1; UND. declivis 4, dilatata 2, hyalina 3, ostenfeldi 1, peruana 4; AMPL. monocollaria 1; UDPS. angulata 1, pacifica 2, tricollaria 1, umbilicata 1; DICT. mitra 1, pacifica 7, reticulata 2; STEEN. gracilis 1, steenstrupii 1; AMPH. quadrilineata 2; DAD. cuspis 1, ganymedes 1; ORM. cornucopia 1, schmidti 1; EUT. birictus 1, elongatus 1, tenuis 1; DAT. stramonium 1.

Salpa stomach: 64 loricæ counted; 64 identified; 19 spp.:

POR. curtus 1; EPIOR. healdi 2; CRAT. armilla 3, urceolata 9; ACAN. minutissima 13, obtusa 9; PROTORH. curta 1, mira 1; RHAB. conica 1, exilis 1; RDPS. triton 5; PROP. claparèdei 3; DICT. pacifica 1, reticulata 1, tiara 1; AMPH. minor 3; DAD. ganymedes 4; EUT. apertus 1, tenuis 4.

4682. 19° 7′ S.; 90° 10′ W. 8–XII–'04. 69° F.

Surface: 100 loricæ counted; 110 identified; 21 spp.:

COD. apicata 2%, galea 1; CDNR. lata 63, mucronata 1; CDPS. ollula 1; CYTT. eucecryphalus 2, longa 2; EPIP. exigua 9; EPIC. nervosa 1; RDPS. longicaulis 1, triton 6; XYST. longicauda 4; XPS. tropica 1; PROP. biangulata 1, ellipsoida 1, parva 1; DICT. mitra 2, reticulata 4; AMPH. quadrilineata 4; EUT. birictus 1, elongatus 2.

4683. 20° 2′ S.; 91° 52′ W. 9–XII–'04. 70° F.

300–0 fms.: 100 loricæ counted; 127 identified; 59 spp.:

COD. amphorella 5%, diomedæ 1; CDNR. lata 16, mucronata 1; CDPS. ollula 1; CDLLPS. inflata 10, parva 2; CYTT. brandti 3, eucecryphalus 7, longa 2; POR. curtus 1; EPIP. constricta 1, exigua 8, pacifica 2, sargassensis 2; EPIC. nervosa 3; PET. foli 1, major 2; PROTORH. curta 1; RDPS. longicaulis 1, minima 1; PAR. aciculifera 1, attenuata 3, inflata 3, messinensis 1; XYST. acus 1, longicauda 1; XPS. armata 3, cyclas 1, dahli 2, hastata 1, inæqualis 1, krämeri 1, paradoxa 1, tenuirostris 1, tropica 1; PROP. amphora 1, claparèdei 2, ellipsoida 2, ovata 1; UND. declivis 2, ostenfeldi 1, peruana 1; AMPL. collaria 1, monocollaria 2; UDPS. pacifica 1, tricollaria 1; CRIC. quadridivisa 1; DICT. mitra 3, pacifica 1, reticulata 5, spinosa 1; CANTH. septinaria 1; AMPH. quadrilineata 2; ORM. schmidti 1; EUT. elongatus 3, tenuis 1; SALP. ricta 2; RHABDS. cuneolata 1.

4684. 20° 40′ S.; 93° 19′ W. 9–XII–'04. 71° F.

Surface: 100 loricæ counted; 106 identified; 20 spp.:

COD. apicata 1%; CDPS. ollula 1; CYTT. eucecryphalus 1; EPIP. exigua 3, exquisita 2; EPIC. nervosa 1; RHAB. striata 1; RDPS. minima 34, triton 3; XYST. longicauda 1; PROP. claparèdei 2, subangulata 1; STEEN. gracilis 5, steenstrupii 1; AMPH. quadrilineata 27; ORM. schmidti 1; EUT. birictus 2, elongatus 14, lusus-undæ 4, macilentus 1.

4685. 21° 36′ S.; 94° 56′ W. 10–XII–'04. 72° F.

300–0 fms.: 100 loricæ counted; 128 identified; 38 spp.:

COD. apicata 4%, galea 2; CDNR. benguelensis 1; CDPS. ollula 3; CLIM. scalaria 3; CYTT. brandti 1, eucecryphalus 3, mucronata 1; EPIP. exigua 2, sargassensis 1; EPIC. nervosa 4; RDPS. longicaulis 1, minima 39, triton 1; PAR. caudata 1, inflata 1; XYST. acus 1, treforti 2; XPS. clevei 1, conicacauda 1, cymatica 1, favata 1, paradoxa 1, spicata 3; PROP. claparèdei 2, ellipsoida 2; UND. declivis 5, hyalina 3, peruana 1; AMPL. collaria 1, monocollaria 1; UDPS. pacifica 1, umbilicata 1; CRIC. quadricincta 1, quadridivisa 1; AMPH. quadrilineata 6; EUT. elongatus 7; SALP. acuminata 1.

800–0 fms.: 4 loricæ counted; 4 identified; 4 spp.:

CDLLPS. parva 25%; CYTT. eucecryphalus 25; CYTT. mucronata 25; AMPH. quadrilineata 25.

4686. 22° 2′ S.; 95° 52′ W. 10–XII–'04. 71° F.

Surface: 100 loricæ counted; 100 identified; 7 spp.:

CDNR. lata 6%, mucronata 1; CYTT. eucecryphalus 1; RDPS. minima 86; PROP. claparèdei 1, prælonga 1; EUT. elongatus 4.

4687. 22° 49′ S.; 97° 30′ W. 11–XII–'04. 73° F.

300–0 fms.: 75 loricæ counted; 78 identified; 36 spp.:

COD. apicata 1%, galea 1; CDNR. benguelensis 1, lata 6; CDPS. ollula 3; CDLLPS. minor 4; COX. laciniosa 1; CLIM. scalaria 3; CYTT. acutiformis 1, brandti 2, eucecryphalus 2, longa 1, EPIP. exquisita 1, pacifica 4; EPIOR. acuta 3; EPIC. nervosa 4; RHAB. striata 1; RDPS. minima 33; XYST. treforti 1; XPS. clevei 1, cyclas 1, dahli 3, krämeri 1, tropica 3; PROP. perpusilla 1; UND. declivis 3, hyalina 1; AMPL. collaria 1; UDPS. tricollaria 3, truncata 1; DICT. mitra 1; STEEN. gracilis 1, steenstrupii 4; AMPH. quadrilineata 1; ORM. schmidti 1; EUT. birictus 3.

2125–0 fms.: wing net.

PAR. inflata 1 lorica

4688. 23° 17′ S.; 98° 37′ W. 11–XII–'04. 72° F.

Surface: 100 loricæ counted; 100 identified; 1 sp.:

RDPS. minima 100%.

Easter Island Eddy. Stations 4689–4700.

4689. 24° 5′ S.; 100° 20′ W. 12–XII–'04. 72° F.

300–0 fms.: 100 loricæ counted; 125 identified; 41 spp.:

COD. apicata 1%, galea 1; CDNR. lata 1, oceanica 1; CDLLPS. minor 1; CLIM. scalaria 2; CYTT. acutiformis 1, brandti 1, eucecryphalus 4; EPIP. sargassensis 2; EPIC. nervosa 3; PET. major 3; RDPS. minima 49; PAR. aciculifera 1, aculeata 1, attenuata 1, difficilis 2, inflata 1; XYST. longicauda 1, treforti 2; XPS. clevei 1, conicacauda 1, cymatica 1, favata 2, krämeri 2, pulchra 1, spicata 6; PROP. biangulata 1, claparèdei 1, ostenfeldi 1; UND. declivis 6, ostenfeldi 1; AMPL. collaria 1; AMPLS. angularis 1; UDPS. tricollaria 4, umbilicata 1; CRIC. quadricincta 1, quadridivisa 1; STEEN. gracilis 1; EUT. turgescens 1; SALP. acuminata 1.

800–0 fms.: 50 loricæ counted; 52 identified; 24 spp.:

CDNR. lata 10%; CDPS. ollula 2; CLIM. scalaria 2; CYTT. brandti 2, longa 4, mucronata 2; EPIP. exquisita 4, sargassensis 2; PET. major 6; RDPS. minima 36; PAR. aculeata 2, inflata 1; XYST. treforti 2; XPS. conicacauda 2, cymatica 4, paradoxa 2, pulchra 1, spicata 4; PROP. amphora 2; AMPL. collaria 2; monocollaria 2; UDPS. tricollaria 4; CRIC. quadricincta 2; DICT. reticulata 2.

4690. 24° 45′ S.; 101° 45′ W. 12–XII–'04. 73° F.

Surface: 100 loricæ counted; 113 identified; 14 spp.:

COD. apicata 1%; CDNR. lata 1; CDPS. ollula 1; CDLLPS. longa 1; EPIP. constricta 1, exquisita 1; PROTORH. simplex 1; RDPS. minima 98; XPS. clevei 1; EUT. birictus 1, brandti 2, elongatus 1, procurrerens 1, stramentus 1.

4691. 25° 27′ S.; 103° 29′ W. 13–XII–'04. 73° F.

300–0 fms.: 50 loricæ counted; 56 identified; 30 spp.:

COD. galea 4%; CDPS. ollula 1; CYTT. brandti 4, longa 6; EPIP. sargassensis 8; EPIC. nervosa 2; PET. major 4; PROTORH. simplex 1; RDPS. minima 24; PAR. attenuata 2; XYST. treforti 6; XPS. clevei 4, cyclas 2, cymatica 2, krämeri 1, spicata 2; PROP. ellipsoida 1; UND. bulla 1, declivis 2, ostenfeldi 2; AMPL. collaria 4, monocollaria 1; UDPS. tricollaria 2, umbilicata 2; CRIC. quadricincta 4, quadridivisa 2; ORM. schmidti 2; EUT. brandti 4, procurrerens 4; SALP. attenuata 2.

4692. 25° 40′ S.; 104° 1′ W. 13–XII–'04. 73° F.

Surface: 100 loricæ counted; 101 identified; 3 spp.:

RDPS. minima 99%; EUT. elongatus 1, medius 1.

4694. 26° 34′ S.; 108° 57′ W. 22–XII–'04. 72° F.

Surface: 50 loricæ counted; 50 identified; 8 spp.:

COD. apicata 2%; CDLLPS. longa 2; CYTT. eucecryphalus 2; FAV. azorica 8; EPIC. nervosa 4; RDPS. minima 58; EUT. elongatus 20, procurrerens 4.

4695. 25° 22′ S.; 107° 45′ W. 23–XII–'04. 74° F.

300–0 fms.: 100 loricæ counted; 107 identified; 34 spp.:

COD. apicata 1%; CDNR. lata 1; CDLLPS. minor 4; CLIM. scalaria 8; CYTT. brandti 3, cassis 2, eucecryphalus 1, longa 2; EPIP. exquisita 4, sargassensis 3; EPIOR. acuta 1; EPIC. nervosa 9; RDPS. minima 17; XYST. lanceolata 1, treforti 7; XPS. clevei 10, cymatica 3, krameri 3, paradoxa 1, spicata 2; PROP. ellipsoida 1, perpusilla 2; UND. declivis 2; AMPL. collaria 5, præcuta 1; UDPS. umbilicata 1; CRIC. quadricincta 3; DICT. occidentalis 1; EUT. macilentus 1, procurrerens 1, tenuis 1; DAT. stramonium 1; SALP. acuminata 1, jugosa 1.

4696. 24° 40′ S.; 107° 5′ W. 23–XII–'04. 74° F.

Surface: 100 loricæ counted; 101 identified; 10 spp.:

CYTT. eucecryphalus 1%; EPIP. exquisita 4; EPIC. nervosa 2; PROTORH. simplex 1; RDPS. longicaulis 1, minima 68; PROP. urna 1; STEEN. steenstrupii 1; EUT. elongatus 12, procurrerens 10.

4697. 23° 24′ S.; 106° 2′ W. 24–XII–'04. 75° F.

300–0 fms.: 100 loricæ counted; 116 identified; 47 spp.:

COD. galea 1%; CDPS. ollula 1; CDLLPS. minor 1; COX. declivis 1; CLIM. scalaria 1; CYTT. brandti 4, eucecryphalus 3, mucronata 1; EPIP. exquisita 3, sargassensis 3; EPIC. nervosa 11; RDPS. minima 35; PAR. attenuata 1, clavus 1, difficilis 1, inflata 1; XYST. longicauda 1, striata 1, treforti 3; XPS. clevei 5, conicacauda 1, epigrus 1, krämeri 3, paradoxa 1, spicata 1; PROP. claparèdei 3, ellipsoida 1, parva 1, perpusilla 1, tenuis 1; UND. bulla 1, declivis 2, ostenfeldi 1; AMPL. ampla 1, collaria 5; AMPLS. angularis 1; UDPS. tricollaria 1; CRIC. quadricincta 1; AMPH. quadrilineata 1; ORM. cornucopia 1; EUT. birictus 1, elongatus 2, procurrerens 1; SALP. acuminata 1, attenuata 1, faurei 1, secata 1.

4698. 22° 50′ S.; 105° 31′ W. 24–XII–'04. 75° F.

Surface: 25 loricæ counted; 27 identified; 8 spp.:

CDPS. ollula 4%; EPIP. constricta 1, exquisita 16; RDPS. minima 44; XPS. clevei 4; EUT. elongatus 24, medius 1, procurrerens 8.

4699. 21° 39′ S.; 104° 29′ W. 25–XII–'04. 75° F.

300–0 fms.: 100 loricæ counted; 116 identified; 47 spp.:

COD. diomedæ 1%, galea 2, perforata 1; CDNR. lata 1; CDLLPS. longa 4, minor 1; COX. laciniosa 1; CYTT. cassis 1; EPIP. constricta 4, exquisita 2, lata 2, pacifica 1; EPIC. nervosa 6; RDPS. minima 25; PAR. aciculifera 1, aculeata 1, humerosa 1, inflata 1; XYST. minuscula 2, treforti 5; XPS. clevei 3, conicacauda 1, constricta 2, cyclas 3, cymatica 5, spicata 2; PROP. amphora 1, claparèdei 8, ellipsoida 1, parva 1, perpusilla 1; UND. bulla 1, declivis 6; UDPS. amularius 1, tricollaria 1; CRIC. quadridivisa 1; STEEN. steenstrupii 2; AMPH. quadrilineata 1; EUT. birictus 1, elongatus 2, procurrerens 3; DAT. stramonium 1; SALP. acuminata 1, expansa 1, jugosa 1; SALPGC. undata 1; RHABDS. cuneolata 1.

4700. 20° 28′ S.; 103° 26′ W. 25–XII–'04. 74° F.

Surface: 20 loricæ counted; 20 identified; 7 spp.:

CDNR. lata 5%; CYTT. eucecryphalus 10; RDPS. minima 50; PROP. perpusilla 10; DICT. occidentalis 5; EUT. elongatus 15, procurrerens 5.

South Equatorial Drift. Stations 4701–4712

4701. 19° 11′ S.; 102° 24′ W. 26–XII–'04. 72° F.

300–0 fms.: 100 loricæ counted; 341 identified; 91 spp.:

COD. amphorella 1%, apicata 1, diomedæ 1, galea 1; CDNR. lata 1; CDLLPS. inflata 1, longa 7, parva 1, pura 1; COX. laciniosa 2, longa 1; CLIM. scalaria 1; CYTT. brandti 3, cassis 1; EPIP. constricta 1, lata 1, pacifica 2, sargassensis 1; EPIC. nervosa 1; PET. major 2; PROTORH. mira 1, simplex 1; RHAB. cornucopia 1, indica 1, poculum 1; RDPS. longicaulis 2, minima 49, triton 1; PAR. aciculifera 1, aculeata 1, caudata 1, humerosa 1; XYST. clavata 1, minuscula 2, treforti 1; XPS. brandti 1, clevei 1, conicacauda 1, constricta 1, cyclas 1, cymatica 1, favata 1, inæqualis 1, laticincta 1, parva 1, spicata 2; PROP. amphora 1, biangulata 1, claparèdei 3, ellipsoida 1, globosa 1, ostenfeldi 1, ovata 1, parva 1, perpusilla 2, urna 1; UND. declivis 2, dilatata 1, media 1, ostenfeldi 1; AMPL. ampla 1, collaria 1, monocollaria 4, occidentalis 1; AMPLS. angularis 1, biedermanni 1; UDPS. anularius 1, tricollaria 1; CRIC. quadricincta 2, quadridivisa 1;

DICT. duplex 1, fenestrata 1, mitra 1, occidentalis 3, pacifica 1, reticulata 2, spinosa 1; STEEN. gracilis 1, steenstrupii 1; AMPH. quadrilineata 1; STEL. fenestrata 1; EUT. birictus 1, elongatus 1, macilentus 1, medius 1, tenuis 1; DAT. striata 1; SALP. acuminata 1, attenuata 1, gracilis 1; RHABDS. cuneolata 1.

800–0 fms.: 100 loricæ counted; 108 identified; 51 spp.:

COD. amphorella 1, galea 1; CDLLPS. longa 7, pura 1; COX. laciniosa 1; CLIM. scalaria 5; CYTT. brandti 5, cassis 1, eucecryphalus 1; EPIP. lata 1, pacifica 2, sargassensis 2; EPIC. nervosa 1; ACAN. minutissima 1; PET. major 6; PROTORH. mira 1, striatura 1; RHAB. cornucopia 1; RDPS. minima 20, triton 2; PAR. difficilis 1, prætenuis 1; XYST. treforti 3; XPS. clevei 1, cymatica 1, krämeri 1, laticincta 1, spicata 3; PROP. amphora 1, claparèdei 2, ellipsoidea 1, globosa 1, ostenfeldi 1, parva 1, urna 1; UND. declivis 1; AMPL. occidentalis 1; AMPLS. biedermanni 1; CRIC. quadricincta 2, quadridivisa 1; DICT. duplex 1, mitra 1, reticulata 2; AMPH. quadrilineata 3; EUT. birictus 3, elongatus 2, macilentus 1, tenuis 3; DAT. stramonium 1; SALP. acuminata 4, laminata 1.

4702. 18° 39′ S.; 102° 0′ W. 26–XII–'04. 73° F.

Surface: 50 loricæ counted; 50 identified; 12 spp.:

CDLLPS. longa 2%; CYTT. eucecryphalus 8; EPIP. exquisita 14, pacifica 12, sargassensis 2; RDPS. minima 44; XYST. treforti 2; DICT. occidentalis 4; STEEN. gracilis 2; EUT. birictus 2, elongatus 6, tenuis 2.

4703. 17° 18′ S.; 100° 52′ W. 27–XII–'04. 73° F.

300–0 fms.: 100 loricæ counted; 108 identified; 50 spp.:

COD. galea 3%, perforata 2; CDPS. ollula 1; CDLLPS. inflata 3; COX. laciniosa 1; CYTT. eucecryphalus 1; EPIP. blanda 1, exquisita 1, lata 1, pacifica 1, sargassensis 2; EPIC. nervosa 2; PET. major 1; PROTORH. simplex 1; RHAB. conica 1; RDPS. minima 29; PAR. aculeata 1, attenuata 1, difficilis 3; XPS. clevei 1, conicacauda 2, cyclas 1, cymatica 1, favata 1, laticincta 2, spicata 6; PROP. amphora 1, claparèdei 5, ellipsoida 2, globosa 1; UND. declivis 2; AMPL. bulbosa 1, collaria 1; AMPLS. angularis 1; CRIC. quadricincta 1; DICT. mitra 3, reticulata 4; CANTH. septinaria 1; STEEN. steenstrupii 2;

AMPH. amphora 1, quadrilineata 4; ORM. schmidti 1, schweyeri 1; EUT. birictus 1, perminutus 1, stramentus 1, tenuis 1; SALP. gracilis 1, rotundata 1, sinistra 1.

2228–0 fms.: Small wing nets on trawl: 4 loricæ counted;
4 identified; 3 spp.
Not included in computations:

COD. apicata 1 lorica; PAR. aculeata 1 lorica; DICT. reticulata 4 loricæ.

4704. 16° 55′ S.; 100° 24′ W. 27–XII–'04. 73° F.

Surface: 100 loricæ counted; 106 identified; 23 spp.:

COD. apicata 2%, galea 1; CDPS. ollula 2; CDLLPS. pura 1; COX. laciniosa 1; CLIM. scalaria 4; CYTT. eucecryphalus 47; EPIP. blanda 6, exquisita 1, lata 4, pacifica 2; EPIRH. coronata 1; RHAB. amor 1; RDPS. longicaulis 15, minima 2; PAR. lachmanni 1; PROP. parva 1; UND. dilatata 1; DICT. occidentalis 2; STEEN. steenstrupii 5; AMPH. quadrilineata 2; EUT. elongatus 3, tenuis 1.

4705. 15° 5′ S.; 99° 19′ W. 28–XII–'04. 72° F.

300–0 fms.: 100 loricæ counted; 135 identified; 60 spp.:

COD. amphorella 1%, apicata 3, cuspidata 1; CDPS. ollula 4; CDLLPS. inflata 2, parva 6, pura 1; COX. laciniosa 1; CLIM. scalaria 5; CYTT. brandti 3, cassis 1, eucecryphalus 3, longa 2; EPIP. deflexa 1, lata 24, pacifica 1, sargassensis 2; EPIOR. healdi 1; PET. foli 1, major 1; RHAB. amor 7, cornucopia 13; RDPS. longicaulis 5, triton 1; PAR. aculeata 1, attenuata 1, messinensis 1; XYST. treforti 3; XPS. conicacauda 1, cyclas 1, favata 2, hastata 1, inæqualis 5, spicata 1, tropica 1; PROP. parva 2, perpusilla 1, tenuis 1; UND. hemispherica 1, hyalina 1, media 1, ostenfeldi 1, parva 3, turgida 1; AMPL. quadricollaria 1; AMPLS. angularis 1; UDPS. tricollaria 1; DICT. occidentalis 1, reticulata 1; STEEN. steenstrupii 1; AMPH. quadrilineata 1; STEL. fenestrata 1; EUT. birictus 1, brandti 1, colligatus 1, fraknóii 1, lusus-undæ 2, perminutus 1; DAT. stramonium 1; SALP. acuminata 1.

2031–0 fms.: Small wing nets on trawl: 100 loricæ counted; 108 identified; 49 spp.:

COD. amphorella 1%, apicata 4; CDPS. ollula 5; CDLLPS. inflata 1, pura 1; COX. laciniosa 1; CLIM. scalaria 1; CYTT. cassis 1, conica 1, eucecryphalus 6, longa 1; EPIP. exquisita 1, lata 26, pacifica 1; CRAT. armilla 1, protuberans 1; RHAB. amor 4, cornucopia 2; RDPS. longicaulis 5, minima 2; PAR. aciculifera 1, aculeata 1, messinensis 1; XYST. treforti 1; XPS. cymatica 1, favata 3, inæqualis 3, spicata 2, tropica 2; PROP. amphora 1, ostenfeldi 1, perpusilla 1, tenuis 1, urna 1; UND. claparèdei 1, dilatata 1, hyalina 1, media 1, ostenfeldi 1, parva 1; AMPL. occidentalis 1, quadricollaria 1; DICT. reticulata 2; STEEN. steenstrupii 4; AMPH. quadrilineata 3; EUT. fraknóii 3; SALP. acuminata 1; RHABDS. cuneolata 1; EPICR. bellisima 1.

4706. 14° 18′ S.; 98° 45′ W. 28–XII–'04. 72° F.

Surface: 100 loricæ counted; 104 identified; 23 spp.:

COD. apicata 2%; CDNR. mucronata 1; CDPS. ollula 2; CDLLPS. inflata 1, pura 1; CLIM. scalaria 20; CYTT. brandti 1, eucecryphalus 2; EPIP. lata 6, pacifica 2; EPIOR. acuta 2; RDPS. longicaulis 21; XYST. treforti 1; PROP. ellipsoida 4, pentagona 1, prælonga 1, tumida 1; DICT. occidentalis 2; AMPH. quadrilineata 22; EUT. birictus 5, elongatus 3, lusus-undæ 3, perminutus 1.

4707. 12° 33′ S.; 97° 42′ W. 29–XII–'04. 72° F.

300–0 fms.: 100 loricæ counted; 143 identified; 78 spp.:

TPS. mortensenii 1%; COD. amphorella 1, apicata 1, cuspidata 1, galea 1; CDNR. mucronata 1; CDPS. ollula 2; CDLLPS. inflata 6, pura 3, speciosa 1, turgida 1; COX. laciniosa 1; CLIM. scalaria 5; HELIC. longa 1; CYTT. cassis 1, eucecryphalus 1, longa 1; POR. annulatus 1; EPIP. lata 27, pacifica 1, sargassensis 1, undella 1; EPIOR. acuta 1; EPIC. nervosa 2; ACAN. minutissima 1; PET. foli 1, major 1; PROTORH. striatura 1; RHAB. amor 9, indica 1; RDPS. minima 1, triton 4; PAR. aciculifera 2, aculeata 1, attenuata 1, caudata 1, difficilis 1, invaginata 1, prætenuis 1; XYST. minuscula 1, treforti 1; XPS. cyclas 1, cymatica 1, favata 2, hastata 1, inæqualis 1, laticincta 1, paradoxa 1, pulchra 1, spicata 1, tropica 7; PROP. claparèdei 1, cuspidata 1, ellipsoida 3, parva 3, pentagona 1, perpusilla

1; UND. dilatata 1, hemispherica 1; AMPLS. angularis 1; CRIC. quadricincta 1; DICT. duplex 1, mitra 1, minor 1, occidentalis 1, pacifica 1, reticulata 1; AMPH. quadrilineata 3; BDT. palliata 1; STEL. simplex 1; EUT. elongatus 1, fraknóii 1, lusus-undæ 1, perminutus 1, procurrerens 1; SALP. acuminata 1, gracilis 1, tuba 2.

4708. 11° 40′ S.; 96° 55′ W. 29–XII–'04. 72° F.

Surface: 100 loricæ counted; 111 identified; 21 spp.:

COD. apicata 2%; CDLLPS. inflata 1, parva 1; COX. laciniosa 1; CLIM. scalaria 2; CYTT. longa 1; EPIP. lata 31, pacifica 1; EPIOR. acuta 1; RHAB. amor 52; RDPS. triton 2; XYST. minuscula 1, treforti 1; PROP. claparèdei 1, ellipsoida 1; DICT. mitra 1, occidentalis 1, reticulata 7; EUT. perminutus 1; SALPGC. crenulata 1, unguiculata 1.

4709. 10° 15′ S.; 95° 40′ W. 30–XII–'04. 72° F.

300–0 fms.: 100 loricæ counted; 252 identified; 74 spp.:

COD. amphorella 1%, apicata 1, cuspidata 2, galea 1; CDNR. australis 1; CDPS. ollula 1; CDLLPS. cordata 1, ecaudata 1, inflata 16, minor 1, pacifica 1, parva 5, pura 3, speciosa 1, tropica 1, turgescens 1, turgida 3; COX. laciniosa 1; CLIM. scalaria 1; CYTT. cassis 1, longa 2; EPIP. constricta 1, lata 43, pacifica 1; EPIOR. acuta 1; PROTORH. simplex 1; RHAB. amor 5, indica 1, poculum 1, valdestriata 1; RDPS. triton 1; PAR. aciculifera 1, messinensis 1, prætenuis 1; XYST. minuscula 1, treforti 1; XPS. cyclas 1, favata 1, inæqualis 1, ornata 1, pulchra 1, tropica 1; PROP. claparèdei 1, ellipsoida 1, globosa 1, parva 2, pentagona 1; UND. dilatata 1, ostenfeldi 1, parva 1; AMPL. collaria 1; DICT. duplex 1, polygonata 1, reticulata 2, spinosa 1; CANTH. truncata 1; STEEN. gracilis 1, steenstrupii 1; AMPH. quadrilineata 1; DAD. curta 1, cuspis 1, ganymedes 1; ORM. apsteini 1, cornucopia 2; EUT. apertus 1, elongatus 1, tenuis 1; DAT. stramonium 1; SALP. laminata 1, tuba 1, secata 1; SALPGC. ampla 1, perca 1; EPICR. prismatica 1.

4710. 9° 30′ S.; 95° 8′ W. 30–XII–'04. 74° F.

Surface: 25 loricæ counted; 27 identified; 9 spp.:

COD. amphorella 1%, cuspidata 4; EPIP. lata 16; RHAB. amor 14, indica 2; XYST. treforti 1; PROP. perpusilla 8; UND. amphora 20; DICT. reticulata 36.

4711. 7° 47′ S.; 94° 5′ W. 31–XII–'04. 75° F.

300–0 fms.: 100 loricæ counted; 123 identified; 52 spp.:

COD. cuspidata 3%, galea 1; CDNR. mucronata 4; CDLLPS. ecaudata 18, parva 1, pura 3, turgescens 1, turgida 1; COX. pelagica 1; CLIM. scalaria 1; CYTT. longa 1; POR. curtus 1; EPIP. lata 23, pacifica 1; EPIOR. healdi 1; ACAN. minutissima 1; PROTORH. simplex 1; RHAB. amor 9; RDPS. triton 2; PAR. aciculifera 2, aculeata 1, difficilis 1; XYST. minuscula 3, treforti 1; XPS. crassispinosa 1, cyclas 1, hastata 1, pulchra 2, tenuirostris 3, tropica 1; PROP. claparèdei 3, ellipsoida 4, globosa 2, parva 1, pentagona 1, perpusilla 1, prælonga 1; UND. dilatata 1, hemispherica 1, ostenfeldi 1, turgida 1; DICT. minor 1, pacifica 3, reticulata 3, spinosa 1; STEEN. robusta 1, steenstrupii 1; ORM. schweyeri 1; STEL. fenestrata 1; EUT. tenuis 1; SALP. acuminata 1, tuba 1.

800–0 fms.: 9 loricæ counted; 9 identified; 6 spp.:

CYTT. eucecryphalus 34%; EPIP. lata 22; XYST. treforti 11; XPS. pulchra 11; PROP. ellipsoida 11; STEL. stelidium 11.

4712. 7° 5′ S.; 93° 35′ W. 31–XII–'04. 74° F.

Surface: 100 loricæ counted; 114 identified; 34 spp.:

COD. apicata 1%; CDNR. mucronata 1; CDLLPS. ecaudata 7, pura 1; COX. laciniosa 1; CYTT. eucecryphalus 1, longa 1; EPIP. lata 7, pacifica 4; PET. major 1; PROTORH. simplex 1; RHAB. amor 8, indica 1, spiralis 1; RDPS. constricta 1, triton 36; XYST. minuscula 4, treforti 1; XPS. cymatica 1, dahli 1; PROP. pentagona 15; UND. turgida 1; DICT. reticulata 5; STEEN. robusta 1, steenstrupii 1; AMPH. amphora 1; DAD. bulbosa 1, ganymedes 1; EUT. brandti 1, elongatus 1, tenuis 2, turgescens 2; SALP. acuminata 1, subconica 1.

Galapagos Eddy. Stations 4713–4716

4713. 5° 35′ S.; 92° 21′ W. 1–I–'05. 73° F.

150–0 fms.: 50 loricæ counted; 53 identified; 17 spp.:

COD. amphorella 1%; CLIM. scalaria 2; EPIP. lata 8, pacifica 1; RHAB. amor 10; RDPS. triton 8; PAR. aculeata 1, caudata 1; XYST. minuscula 32, treforti 2; XPS. pulchra 16; PROP. pentagona 4; AMPH. quadrilineata 2; EUT. perminutus 2, procurrerens 8, tenuis 4, turgescens 4.

300–0 fms.: 100 loricæ counted; 289 identified; 84 spp.:

COD. amphorella 1%, diomedæ 1; CDNR. mucronata 2; CDLLPS. ecaudata 2, inflata 1, meridionalis 1, minor 1, turgescens 2; COX. fabricatrix 1; CLIM. scalaria 1; CYTT. longa 2; POR. apicatus 1, curtus 1; EPIP. lata 1, pacifica 1, sargassensis 1; EPIOR. healdi 2; CRAT. armilla 1; PROTORH. striatura 1; RHAB. amor 1, brandti 1, indica 1, poculum 1; RDPS. intermedia 2, minima 1, triton 13; PAR. aciculifera 1, aculeata 2, acuta 1, attenuata 1, caudata 1, gigantea 1, humerosa 1, invaginata 1, messinensis 1; XYST. minuscula 11, treforti 1; XPS. armata 1, crassispinosa 1, cyclas 1, hastata 8, inæqualis 1, ornata 1, pulchra 16, spicata 3, tenuirostris 1; PROP. cuspidata 1, ellipsoida 1, globosa 1, ostenfeldi 1, parva 2, pentagona 4, perpusilla 1, subacuta 1, subangulata 1; UND. dilatata 1, hyalina 1, turgida 1; AMPL. monocollaria 1; AMPLS. angularis 1; UDPS. cubitum 5, pacifica 3; DICT. minor 1, pacifica 2, polygonata 1, reticulata 4, spinosa 1; STEEN. gracilis 2; AMPH. minor 2; ORM. apsteini 1, cornucopia 1, hæckeli 2; EUT. elongatus 1, perminutus 1, tenuis 3, turgescens 6; DAT. stramonium 1; SALP. acuminata 1, attenuata 1, curta 1, subconica 1, tuba 1; SALPGC. crenulata 1, unguiculata 1.

4714. 4° 19′ S.; 91° 28′ W. 1–I–'05. 75° F.

Surface: 100 loricæ counted; 100 identified; 4 spp.:

EPIOR. acuta 2%; RDPS. triton 16; XYST. minuscula 81; EUT. tubulosus 1.

4715. 2° 40′ S.; 90° 19′ W. 2–I–'05. 75° F. Galapagos Eddy.

300–0 fms.: 100 loricæ counted; 158 identified; 55 spp.:

CDLLPS. parva 1%, pura 1; COX. laciniosa 1; CLIM. scalaria 1; CYTT. longa 1; EPIP. constricta 1, lata 1, pacifica 1; EPIOR. acuta 30; ACAN. conicoides 1; RHAB. amor 2, quantula 1; RDPS. triton 1; PAR. aciculifera 6, aculeata 2, acuta 1, attenuata 1, caudata 2, difficilis 1, humerosa 1, inflata 1, invaginata 4, messinensis 2; XYST. minuscula 8, treforti 3; XPS. cymatica 1, dicymatica 1, hastata 1, heroica 1, inæqualis 3, pulchra 1, spicata 1, tenuirostris 3, torta 1, tropica 1; PROP. claparèdei 4, ostenfeldi 1, parva 3, perpusilla 8; UDPS. pacifica 1; DICT. pacifica 1, reticulata 2; AMPH. quadrilineata 2; DAD. acutiformis 1, bulbosa 1; ORM. cornucopia 1; BDT. palliata 1; STEL. fenestrata 1; EUT. colligatus 4, tenuis 1, tubulosus 1; DAT. stramonium 1; SALP. acuminata 1, subconica 2; EPICR. magnifica 1.

800–0 fms.: 50 loricæ counted; 53 identified; 23 spp.:

CDNR. mucronata 2%; CDLLPS. parva 4, pura 1; CLIM. scalaria 2; CYTT. longa 1; EPIOR. acuta 22, healdi 1; RDPS. triton 4; PAR. aciculifera 2, aculeata 2, caudata 2, difficilis 2; XYST. minuscula 8, treforti 2; XPS. hastata 2, inæqualis 18, spicata 2, tenuirostris 6, tropica 6; PROP. claparèdei 6; DICT. reticulata 2; ORM. schmidti 4; EUT. tenuis 4.

4716. 2° 18′ S.; 90° 2′ W. 2–I–'05. 75° F.

Surface: 100 loricæ counted; 100 identified; 9 spp.:

EPIP. pacifica 1%; EPIOR. acuta 49, healdi 1; RDPS. triton 31; XYST. minuscula 3, treforti 3; AMPH. quadrilineata 1; EUT. elongatus 10, tenuis 1.

South Equatorial Drift. Stations 4717–4741.

4717. 5° 10′ S.; 98° 56′ W. 13–I–'05. 75° F.

300–0 fms.: 100 loricæ counted; 373 identified; 64 spp.:

COD. amphorella 2%, apicata 1; CDNR. mucronata 1; CDLLPS. ecaudata 2, minor 1, pacifica 1, parva 1; COX. laciniosa 3; CYTT. longa 1; EPIP. lata 35, pacifica 1; EPIOR. acuta 1; PROTORH. striatura 3; RHAB. amor 23, indica 1, quantula 1, striata 1; RDPS. longicaulis 1, minima 1, triton 1; PAR. aculeata 2, attenuata 1, difficilis 1; XYST. treforti 1; XPS. conicacauda 1, cyclas 1, favata 1, hastata 1, heroica 1, inæqualis 1, ornata 1, paradoxa 1, pinnata 1, pulchra 1, tenuirostris 2, tropica 1; PROP. claparèdei 6, globosa 3, ovata 1, parva 1, pentagona 6, perpusilla 6; UND. hemispherica 1, ostenfeldi 3; UDPS. pacifica 1; DICT. pacifica 1, reticulata 1; CANTH. septinaria 1; AMPH. quadrilineata 1; DAD. bulbosa 1; ORM. schweyeri 1; STEL. fenestrata 1; EUT. elongatus 1, fraknóii 1, tenuis 1; DAT. recta 3, striata 1; SALP. acuminata 1, incurva 1, rotundata 1, subconica 1; SALPGC. crenulata 1; RHABDS. cuneolata 1; EPICR. prismatica 1.

800–0 fms.: 50 loricæ counted; 65 identified; 30 spp.:

COD. amphorella 1%, apicata 1; CDLLPS. ecaudata 1, turgescens 2; COX. laciniosa 2; CYTT. acutiformis 6, longa 8; EPIP. lata 32; RHAB. amor 16, quantula 1; RDPS. longicaulis 1, triton 1; PAR.

aciculifera 1, aculeata 1, attenuata 2; XPS. heroica 1, krämeri 1, pulchra 1, spicata 2; PROP. claparèdei 1, ellipsoidea 4, pentagona 1, perpusilla 8; UND. ostenfeldi 3; ORM. cornucopia 1, schweyeri 1; EUT. fraknóii 1; DAT. recta 6; SALP. acuminata 6, subconica 2.

4718. 5° 32′ S.; 99° 32′ W. 13–I–'05. 76° F.

Surface: 100 loricæ counted; 108 identified; 19 spp.:

COD. galea 1%; CDNR. mucronata 1; CDLLPS. californiensis 1, parva 1; EPIP. lata 25; CRAT. armilla 1; PET. major 1; RHAB. amor 61, quantula 1; XPS. armata 1; PROP. amphora 1, claparèdei 1, globosa 1, pentagona 2, perpusilla 1; UND. ostenfeldi 1; DICT. reticulata 1; STEEN. steenstrupii 5; DAD. ganymedes 1.

4719. 6° 28′ S.; 101° 16′ W. 14–I–'05. 75° F.

300–0 fms.: 125 loricæ counted; 276 identified: 56 spp.:

COD. amphorella 1%, apicata 2, cuspidata 1; CDNR. australis 1, mucronata 3; CDLLPS. ecaudata 3, parva 1, pura 1, turgescens 2; COX. laciniosa 1; CYTT. acutiformis 1, brandti 1, longa 1, ricta 1; EPIP. deflexa 1, lata 62, pacifica 1; PET. major 1; RHAB. amor 8, brandti 1, poculum 1, spiralis 1; RDPS. triton 1; PAR. aciculifera 1, aculeata 1, caudata 1, difficilis 1, inflata 1, messinensis 1; XYST. minuscula 1, treforti 1; XPS. cyclas 1, dahli 1, favata 1, hastata 1, inæqualis 1, tenuirostris 1; PROP. claparèdei 1, ellipsoidea 1, ovata 1, parva 1, pentagona 7, perpusilla 2; UND. hemispherica 1, ostenfeldi 1; UDPS. pacifica 1; DICT. reticulata 1; CANTH. septenarius 1; ORM. cornucopia 1; EUT. brandti 1, fraknóii 1, perminutus 1; DAT. stramonium 1; SALP. acuminata 1, curta 1, ricta 1.

4720. 7° 13′ S.; 102° 31′ W. 14–I–'05. 76° F.

Surface: 50 loricæ counted; 50 identified; 14 spp.:

CDNR. mucronata 2%; CDLLPS. parva 4; CYTT. acutiformis 2; EPIP. lata 64, pacifica 2; EPIOR. acuta 2; PET. major 2; PROTORH. simplex 2, striatura 1; RHAB. amor 6; RDPS. triton 2; PROP. claparèdei 2, pentagona 8; UND. turgida 1.

4721. 8° 7′ S.; 104° 10′ W. 15–I–'05. 75° F.

300–0 fms.: 100 loricæ counted; 219 identified; 73 spp.:

COD. amphorella 1%, apicata 1; CDNR. mucronata 2, oceanica 1; CDLLPS. parva 1, pura 1, turgescens 3; CYTT. brandti 1, mucronata

1; EPIP. lata 30, pacifica 3, sargassensis 1, undella 1; EPIOR. acuta 1; CRAT. armilla 1; PET. major 1; PROTORH. simplex 4; RHAB. amor 7, exilis 1, indica 1, spiralis 2, torta 1; RDPS. intermedia 6, triton 1; PAR. aciculifera 1, acuta 1, caudata 1, difficilis 2, gigantea 1, inflata 1, messinensis 1; XYST. treforti 4; XPS. brandti 1, constricta 1, cyclas 1, cymatica 1, dahli 1, dicymatica 1, favata 1, hastata 2, inæqualis 1, tenuirostris 1; PROP. claparèdei 1, ostenfeldi 2, ovata 1, parva 2, pentagona 7, perpusilla 2, tenuis 1; UND. ostenfeldi 1; DICT. pacifica 1, minor 1, reticulata 4; CANTH. brevis 1; STEEN. gracilis 1, robusta 1, steenstrupii 2; AMPH. quadrilineata 2; ODONT. serrulata 4; DAD. ganymedes 1; ORM. cornucopia 1, hæckeli 1; BDT. palliata 1; STEL. simplex 1; EUT. elongatus 1, fraknóii 1, lusus-undæ 2, pacificus 1, tenuis 2; DAT. stramonium 1; SALP. acuminata 1, curta 2; EPICR. dextra 1.

800–0 fms.: 17 loricæ counted; 17 identified; 11 spp.:

CYTT. acutiformis 12%, longa 12; EPIP. lata 6, sargassensis 6; PET. major 6; RHAB. indica 6; RDPS. longicaulis 6, triton 22; PAR. aciculifera 6; DICT. reticulata 6; STEEN. steenstrupii 12.

4722. 9° 31′ S.; 106° 30′ W. 16–I–'05. 75° F.

300–0 fms.: 100 loricæ counted; 164 identified; 97 spp.:

COD. amphorella 1%; apicata 2, cuspidata 1; CDNR. oceanica 1; CDLLPS. biedermanni 1, californiensis 1, inflata 1, meridionalis 1, parva 2, pura 16, turgescens 1, turgida 1; CLIM. scalaria 4; CYTT. acutiformis 1, brandti 1, mucronata 1; EPIP. lata 12, pacifica 1, sargassensis 1; EPIOR. acuta 1; CRAT. urceolata 1; ACAN. conicoides 1, lata 1, obtusa 1; PET. major 1; PROTORH. simplex 1; RHAB. amor 12, cornucopia 1, exilis 1, indica 1, spiralis 2; RDPS. intermedia 1, longicaulis 1, minima 1, triton 1; PAR. aciculifera 1, aculeata 1, acuta 1, attenuata 1, caudata 1, difficilis 1, inflata 1, messinensis 1, prætenuis 1; XYST. treforti 1; XPS. brandti 1, cyclas 1, cymatica 2, dicymatica 1, favata 1, hastata 1, heroica 2, inæqualis 1, paradoxa 1, spicata 2, tenuirostris 1; PROP. cuspidata 1, ostenfeldi 4, ovata 1, parva 2, pentagona 3, perpusilla 1; UND. hemispherica 2, hyalina 1, media 2, ostenfeldi 1; AMPL. collaria 1; DICT. fenestrata 1, pacifica 1, reticulata 3; CANTH. brevis 1, truncata 1; STEEN. gracilis 1, steenstrupii 1; AMPH. quadrilineata 7; DAD. ganymedes 1; ORM. bresslaui 1, hæckeli 1, schmidti 1, schweyeri 1; STEL. fenestrata 1; EUT. birictus 1, elongatus 1, fraknóii 1, pacificus 1, perminutus 1,

procurrerens 1, tenuis 1, tubiformis 1, tubulosus 1, turgescens 1; DAT. stramonium 1; SALP. acuminata 1, attenuata 1, faurei 1, gracilis 3; RHABDS. cuneolata 1.

4723. 10° S.; 107° 45′ W. 16–I–'05. 76° F.

Surface: 100 loricæ counted; 106 identified; 37 spp.:

COD. apicata 2%; CDNR. mucronata 1; CDLLPS. parva 4, pura 4; CLIM. scalaria 5; CYTT. acutiformis 1, eucecryphalus 1; EPIP. lata 1, pacifica 1; EPIOR. acuta 1; PROTORH. simplex 5, striatura 2; RHAB. amor 4, spiralis 2; RDPS. longicaulis 1; XYST. treforti 1; PROP. claparèdei 1, globosa 1, ostenfeldi 1, perpusilla 2; DICT. minor 1, pacifica 1, reticulata 13; STEEN. robusta 1, steenstrupii 1; AMPH. amphora 1, quadrilineata 22; EUT. brandti 1, colligatus 1, elongatus 10, lusus-undæ 2, macilentus 1, perminutus 1, procurrerens 1, tenuis 2, tubiformis 5; SALP. acuminata 1.

4724. 11° 13′ S.; 109° 39′ W. 17–I–'05. 79° F.

300–0 fms.: 100 loricæ counted; 221 identified; 109 spp.:

TPS. ornata 1%; COD. amphorella 1, apicata 7; CDNR. cuspidata 1, mucronata 1; CDLLPS. biedermanni 1, inflata 1, meridionalis 1, pacifica 1, parva 5, pura 3, speciosa 1; COX. laciniosa 1, longa 1; CLIM. scalaria 4; CYTT. acutiformis 2, brandti 1, eucecryphalus 1, mucronata 1; POR. apicatus 1, apiculatus 1, curtus 1; EPIP. constricta 1, exquisita 1, lata 1, pacifica 1, sargassensis 1, undella 1; EPIOR. acuta 1; CRAT. armilla 1, urceolata 1; ACAN. conicoides 1, lata 1, minutissima 1; PROTORH. simplex 3, striatura 2; RHAB. amor 20, cornucopia 1, exilis 1, indica 2, spiralis 7; RDPS. longicaulis 1, minima 1; PAR. aciculifera 1, aculeata 2, attenuata 1, clavus 1, difficilis 1, gigantea 1, inflata 2, messinensis 1; XYST. treforti 2; XPS. brandti 1, conicacauda 1, cyclas 1, cymatica 3, favata 1, hastata 1, heroica 1, inæqualis 1, laticincta 1, paradoxa 1, spicata 1, tenuirostris 1; PROP. claparèdei 1, ostenfeldi 1, ovata 2, parva 2, pentagona 1, perpusilla 2; UND. dilatata 3, hyalina 1, parva 1, ostenfeldi 1; AMPL. collaria 1, monocollaria 1, occidentalis 1; DICT. mitra 1, reticulata 4; STEEN. gracilis 1, robusta 1, steenstrupii 1; AMPH. quadrilineata 4; AMPHS. lævis 1, turbinea 1; ODONT. serrulata 1; DAD. cuspis 1, ganymedes 1; ORM. apsteini 1, bresslaui 1, cornucopia 1, schmidti 1, schweyeri 2; STEL. fenestrata 1, stelidium 1; EUT. elongatus 1, macilentus 1, pacificus 1, procurrerens 1, tenuis 1, tubiformis 1, tubu-

losus 1, turgescens 1; DAT. ora 1; SALP. acuminata 2, curta 3, gracilis 1; SALPGC. unguiculata 1; EPICR. prismatica 1.

800–0 fms.: 100 loricæ counted; 114 identified; 49 spp.:

COD. amphorella 1%, apicata 1; CDLLPS. pacifica 5, parva 16, pura 5; CLIM. scalaria 3; CYTT. acutiformis 1, brandti 1, eucecryphalus 1; EPIP. lata 4, pacifica 2; EPIOR. acuta 1; PET. major 1; PROTORH. simplex 2; RHAB. amor 11, cornucopia 1, indica 1, spiralis 5; RDPS. longicaulis 1; PAR. aculeata 1, inflata 3; XPS. brandti 1, conicacauda 1, favata 1, hastata 4, heroica 1, inæqualis 1, laticincta 1, paradoxa 3; PROP. ovata 2, parva 1, pentagona 1, perpusilla 1, tenuis 1, urna 1; UND. ostenfeldi 1, parva 2; DICT. reticulata 3; STEEN. steenstrupii 1; AMPH. quadrilineata 3; DAD. ganymedes 1; STEL. fenestrata 1; EUT. fraknóii 1, procurrerens 2; DAT. ora 3; SALP. acuminata 1, curta 1, faurei 1, jugosa 1.

4725. 11° 38′ S.; 110° 5′ W. 17–I–'05. 77° F.

Surface: 100 loricæ counted; 100 identified; 21 spp.:

COD. apicata 1%; CDNR. mucronata 1; CDLLPS. pura 1; CYTT. acutiformis 22, eucecryphalus 3; EPIP. exquisita 1, lata 2, pacifica 1, undella 14; RHAB. amor 1, indica 4, spiralis 31; RDPS. minima 3; XPS. brandti 1; PROP. globosa 3, pentagona 3; STEEN. robusta 1, steenstrupii 1; EUT. elongatus 6, macilentus 1, procurrerens 1.

4727. 13° 3′ S.; 112° 44′ W. 18–I–'05. 77° F.

Surface: 50 loricæ counted; 59 identified; 28 spp.:

COD. apicata 6%; CDNR. mucronata 2; CDLLPS. parva 2; COX. laciniosa 2; CLIM. scalaria 2; CYTT. acutiformis 8, brandti 4, eucecryphalus 1; EPIP. exquisita 4, lata 2, sargassensis 4, undella 6; PROTORH. simplex 4; RHAB. amor 1, cornucopia 22; RDPS. longicaulis 4, minima 2; PROP. globosa 1; UND. hemispherica 2, hyalina 4; DICT. lepida 1, reticulata 8; STEEN. robusta 2, steenstrupii 2; AMPH. quadrilineata 2; DAD. ganymedes 2; EUT. procurrerens 1; SALP. acuminata 6.

4728. 13° 47′ S.; 114° 21′ W. 19–I–'05. 77° F.

300–0 fms.: 100 loricæ counted; 120 identified; 47 spp.:

COD. amphorella 1%, apicata 6, cuspidata 5; CDLLPS. inflata 3, parva 1, pura 6; CLIM. scalaria 1; CYTT. acutiformis 1, brandti 1;

EPIP. constricta 6, pacifica 4, sargassensis 1; EPIOR. ralumensis 4; PET. major 1; PROTORH. simplex 2, striatura 1; RHAB. amor 1, cornucopia 16; RDPS. minima 1; PAR. attenuata 1, difficilis 2; XPS. brandti 1, cymatica 3, favata 1, paradoxa 2, tenuirostris 1; PROP. parva 3, perpusilla 2; UND. dilatata 1, hemispherica 1, hyalina 1, ostenfeldi 1; AMPLS. angularis 1; DICT. mitra 1, pacifica 1, reticulata 17, spinosa 1; AMPH. quadrilineata 3; ORM. schmidti 2; EUT. elongatus 1, procurrerens 3, tenuis 1; DAT. stramonium 1; SALP. acuminata 2, curta 1, faurei 2, secata 1.

800–0 fms.: 50 loricæ counted; 55 identified; 29 spp.:

COD. amphorella 1%, apicata 4; CDPS. pura 4; CLIM. scalaria 4; CYTT. acutiformis 14, brandti 4, eucecryphalus 2; EPIP. pacifica 4; EPIOR. ralumensis 2; PET. major 2; RHAB. amor 1, cornucopia 10; XYST. treforti 4; XPS. brandti 2, paradoxa 2, tenuirostris 2; PROP. claparèdei 4, pentagona 2, perpusilla 1; UND. hyalina 4; DICT. reticulata 14, spinosa 2; AMPH. quadrilineata 2; ORM. schmidti 2; EUT. tenuis 4; SALP. acuminata 2, curta 2, faurei 2, gracilis 2.

4729. 14° 15′ S.; 114° 13′ W. 19–I–'05. 78° F.

Surface: 50 loricæ counted; 54 identified; 18 spp.:

COD. apicata 6%; COX. laciniosa 2; CLIM. scalaria 4; CYTT. acutiformis 4, mucronata 2; EPIP. pacifica 6; RHAB. amor 1, cornucopia 16; PAR. messinensis 2; XYST. treforti 1; PROP. claparèdei 2, tenuis 2; UND. hemispherica 2; DICT. lepida 4, reticulata 18; AMPH. quadrilineata 22; EUT. colligatus 8, elongatus 2.

4730. 15° 7′ S.; 117° 1′ W. 20–I–'05. 79° F.

300–0 fms.: 100 loricæ counted; 125 identified; 63 spp.:

COD. amphorella 1%, apicata 11, cuspidata 3; CDLLPS. longa 6, parva 1, pura 1, turgescens 1; CLIM. scalaria 6, scalaroides 1; CYTT. brandti 3, eucecryphalus 1, mucronata 1; EPIP. lata 1, pacifica 5, sargassensis 1, undella 1; EPIOR. acuta 1, ralumensis 2; ACAN. minutissima 1; RHAB. amor 1, cornucopia 11; RDPS. longicaulis 2, minima 1; PAR. aculeata 1, attenuata 1, difficilis 1, gigantea 1, inflata 2; XYST. treforti 4; XPS. conicacauda 1, cyclas 1, cymatica 1, favata 2, hastata 1, paradoxa 1, tropica 1; PROP. claparèdei 2, parva 2, pentagona 1, perpusilla 3; UND. declivis 1, hemispherica 2, ostenfeldi 2, parva 3; AMPL. collaria 1; AMPLS. angularis 1; DICT. reticulata 2; AMPH. minor 1, quadrilineata 4; ORM. schmidti 1, schweyeri 1;

STEL. fenestrata 1; EUT. birictus 1, colligatus 3, elongatus 1, fraknóii 1, procurrerens 1; tenuis 4; SALP. acuminata 1, rotunda 1, secata 1; RHABDS. octogenata 1; EPICR. prismatica 1.

4731. 15° 47′ S.; 118° 22′ W. 20–I–'05. 79° F.

Surface: 50 loricæ counted; 54 identified; 29 spp.:

COD. apicata 2%; CLIM. scalaria 8; CYTT. acutiformis 2, brandti 2; EPIP. pacifica 6, sargassensis 1, undella 2; RHAB. amor 1, indica 14; RDPS. constricta 2, longicaulis 12; PAR. attenuata 2, difficilis 2; XYST. treforti 2; XPS. cymatica 2, inæqualis 2, apicata 2; PROP. globosa 4, tenuis 2; UND. hemispherica 4; DICT. duplex 2, reticulata 1; STEEN. robusta 2, steenstrupii 2; AMPH. amphora 2, quadrilineata 10; EUT. colligatus 10, elongatus 4, tubiformis 2.

4732. 16° 32′ S.; 119° 59′ W. 21–I–'05. 79° F.

300–0 fms.: 100 loricæ counted; 112 identified; 50 spp.:

COD. amphorella 2%, apicata 8, cuspidata 4; CDNR. australis 1, mucronata 1; CDLLPS. longa 1, pacifica 1, pura 3; CLIM. scalaria 2; CYTT. brandti 6, eucecryphalus 1; EPIP. constricta 3, exquisita 1, sargassensis 15, undella 3; EPIOR. acuta 1, ralumensis 1; PET. major 4; RHAB. amor 1; RDPS. longicaulis 3; PAR. aciculifera 1, aculeata 1, acuta 1, inflata 1; XYST. treforti 1; XPS. conicauda 1, cyclas 1, cymatica 2, favata 1, inæqualis 1, spicata 2; PROP. claparèdei 1, ellipsoida 1, ostenfeldi 1, perpusilla 1; UND. declivis 4, hemispherica 1; AMPL. occidentalis 1; DICT. reticulata 4, spinosa 1; AMPH. quadrilineata 2; ORM. schmidti 1; BDT. palliata 3; EUT. birictus 1, brandti 1, colligatus 4, elongatus 1, procurrerens 1, tenuis 2; SALP. gracilis 6.

800 fathoms to surface: 100 loricæ counted;

124 identified; 54 spp.:

COD. amphorella 1%, cuspidata 1, diomedæ 1; CDLLPS. pacifica 1, pura 2; CLIM. leiospiralis 1, scalaria 10; CYTT. acutiformis 6, brandti 10, eucecryphalus 3, mucronata 1; POR. apicatus 1; EPIP. constricta 1, exquisita 1, impensa 1, sargassensis 2, undella 2; PET. major 7; PROTORH. simplex 1; RHAB. amor 1; RDPS. longicaulis 4; PAR. aculeata 2, inflata 1, messinensis 1; XYST. treforti 2; XPS. brandti 1, conicacauda 1, cyclas 2, heroica 1, spicata 1, tenuirostris 3; PROP. claparèdei 1, parva 1; UND. hemispherica 1, ostenfeldi 1; DICT.

reticulata 1; STEEN. steenstrupii 1; AMPH. quadrilineata 1; BDT. palliata 4; STEL. fenestrata 1; EUT. birictus 1, brandti 1, colligatus 12, elongatus 1, fraknóii 1, macilentus 1, procurrerens 1, tenuis 5, tubulosus 1, turgescens 1; SALP. acuminata 1, faurei 1, ricta 5, subconica 1.

4733. 16° 57′ S.; 120° 48′ W. 21–I–'05. 80° F.

Surface: 15 loricæ counted; 16 identified; 6 spp.:

CLIM. scalaria 20%; EPIP. undella 40; RHAB. amor 1; RDPS. longicaulis 13; PROP. perpusilla 7; EUT. colligatus 20.

4734. 17° 36′ S.; 122° 35′ W. 22–I–'05. 81° F.

300–0 fms.: 100 loricæ counted; 161 identified; 82 spp.:

COD. amphorella 1%, apicata 4, cuspidata 1; CDNR. australis 1, lata 1; CDLLPS. longa 2, meridionalis 1, pura 7, turgescens 1; COX. longa 1; CLIM. scalaria 2; CYTT. acutiformis 3, brandti 2, eucecryphalus 2, mucronata 1, ricta 1; POR. curtus 1; EPIP. constricta 11, exquisita 1, impensa 1, pacifica 1, sargassensis 2, undella 2; EPIOR. acuta 1, ralumensis 1; ACAN. minutissima 1; PET. major 8; RHAB. amor 5, cornucopia 1, spiralis 1; RDPS. longicaulis 4; PAR. aciculifera 2, aculeata 1, difficilis 4, inflata 1, invaginata 1; XYST. treforti 5; XPS. brandti 1, conicacauda 1, cymatica 3, epigrus 1, inæqualis 1, laticincta 1, paradoxa 1, tenuirostris 1, turgida 1; PROP. claparèdei 1, ostenfeldi 1, parva 1, pentagona 1, perpusilla 1, tenuis 6; UND. declivis 1, hemispherica 1, hyalina 3, media 1, ostenfeldi 1; AMPL. collaria 1; AMPLS. angularis 1; DICT. pacifica 1; CANTH. brevis 1; STEEN. gracilis 1, robusta 1; AMPH. minor 3, quadrilineata 1; BDT. palliata 1; EUT. apertus 1, birictus 1, brandti 1, colligatus 3, fraknóii 1, lusus-undæ 1, macilentus 1, procurrerens 1, tenuis 1, tubiformis 4; SALP. acuminata 1, curta 1, gracilis 1, subconica 1; SALPGC. ampla 2, unguiculata 3.

4735. 18° 16′ S.; 123° 34′ W. 22–I–'05. 81° F.

Surface: 30 loricæ counted; 34 identified; 14 spp.:

COD. apicata 3%; CDLLPS. biedermanni 3, meridionalis 1; CYTT. brandti 3; EPIP. exquisita 14, constricta 21, undella 1; RHAB. cornucopia 3; RDPS. longicaulis 3; PROP. perpusilla 3, tenuis 3; UND. hemispherica 18; DICT. reticulata 21; EUT. elongatus 7.

4736. 19° 4′ S.; 125° 5′ W. 23–I–'05. 81° F.

300–0 fms.: 100 loricæ counted; 128 identified; 52 spp.:

COD. apicata 4%, cuspidata 1; CDNR. australis 1; CDLLPS. biedermanni 1, longa 2, meridionalis 1, pura 2; COX. longa 1; CLIM. scalaria 7; CYTT. brandti 8, eucecryphalus 7, mucronata 1, ricta 1; EPIP. constricta 8, exquisita 9, sargassensis 1, undella 1; ACAN. minutissima 1; PET. major 5; PROTORH. simplex 3; RHAB. amor 1, cornucopia 1, indica 3; RDPS. longicaulis 5; PAR. inflata 1; XYST. treforti 1; XPS. cyclas 1, favata 1, paradoxa 1, tenuirostris 1; PROP. ellipsoida 1, perpusilla 2, tenuis 1; UND. declivis 2, hemispherica 1, hyalina 1; AMPL. collaria 2; AMPLS. angularis 3; DICT. pacifica 1, reticulata 4, spinosa 1; STEEN. steenstrupii 1; BDT. palliata 1; EUT. elongatus 2, fraknóii 1, macilentus 1, tenuis 1, tubulosus 1; SALP. acuminata 2, ricta 1, subconica 1; SALPGC. unguiculata 1.

800–0 fms.: 6 loricæ counted; 6 identified; 6 spp.:

CYTT. brandti 1%; EPIP. constricta 1; RDPS. longicaulis 1; UND. hyalina 1; DICT. reticulata 1; EUT. colligatus 1.

4737. 19° 57′ S.; 127° 20′ W. 24–I–'05. 81°.5 F.

300–0 fms.: 100 loricæ counted; 114 identified; 41 spp.:

COD. apicata 3%, cuspidata 6; CDNR. australis 1, benguelensis 1, lata 2; CDLLPS. biedermanni 1, longa 1, meridionalis 2, parva 1, pura 2; COX. longa 1; CLIM. scalaria 1; CYTT. acutiformis 1, brandti 16, eucecryphalus 5; POR. curtus 1; EPIP. constricta 6, exquisita 3, pacifica 5, sargassensis 11; PET. major 16; RDPS. longicaulis 3; XYST. treforti 1; XPS. dahli 1, laticincta 1, paradoxa 1; PROP. ostenfeldi 1, subangulata 3, urna 1; UND. declivis 1, hemispherica 2, hyalina 1; AMPL. collaria 1; AMPLS. angularis 2; CRIC. quadricincta 1; DICT. reticulata 3; AMPHS. quadrangula 1; EUT. brandti 1, fraknóii 1; SALP. faurei 2, rotundata 1.

550–400 fathoms (Peterson closing net): 8 loricæ counted; 8 identified; 4 spp.:

EPIP. constricta 1; EPIOR. ralumensis 5; UND. ostenfeldi 1; EUT. stramentus 1.

4738. 20° 27′ S.; 128° 30′ W. 24–I–'05. 81° F.

Surface: 6 loricæ counted; 6 identified; 6 spp.:

CLIM. scalaria 17%; PROP. claparèdei 17, perpusilla 17; EUT. elongatus 17, procurrerens 17; SALP. ricta 17.

4739. 22° 11′ S.; 133° 21′ W. 26–I–'05. 79° F.

Drift. Very small catches.

300–0 fms.: 1 lorica counted; 1 identified; 1 spp.:

CYTT. eucecryphalus 100%.

800–0 fms.: 1 lorica counted; 1 identified; 1 spp.:

UND. declivis 100%.

4740. 9° 2′ S.; 123° 20′ W. 11–II–'05. 81° F.

300–0 fms.: to surface: 100 loricæ counted; 156 identified; 54 spp.: COD. amphorella 1%; CDNR. australis 3; CDLLPS. biedermanni 1, inflata 3, meridionalis 1, pura 4; COX. laciniosa 1; CYTT. acutiformis 1, brandti 1, eucecryphalus 1; EPIP. constricta 1, lata 3, pacifica 10, undella 6; EPIOR. ralumensis 7; PET. major 1; PROTORH. curta 1; RHAB. amor 1, cornucopia 8, indica 1; RDPS. longicaulis 1; PAR. aculeata 1, attenuata 1, difficilis 1, inflata 1; XYST. treforti 1; XPS. brandti 1, cymatica 3, favata 3, heroica 1, inæqualis 1, paradoxa 2, tenuirostris 2; PROP. claparèdei 2, ostenfeldi 2, parva 1, perpusilla 1; UND. hemispherica 6, ostenfeldi 1; AMPL. occidentalis 1; DICT. reticulata 3; AMPH. quadrilineata 1; AMPHS. tropica 3; DAD. ganymedes 1; BDT. palliata 1; STEL. simplex 1; EUT. elongatus 4, tenuis 4, tubiformis 4, tubulosus 1; DAT. striata 1; SALP. acuminata 3, faurei 1; EPICR. prismatica 1.

800–0 fms.: 5 loricæ counted; 5 identified; 4 spp.:

RHAB. amor 20%; PROP. perpusilla 20; DICT. reticulata 20; EUT. tenuis 40.

Salpa Stomach: 9 loricæ counted; 9 identified; 6 spp.:

COD. perforata 1; EPIP. deflexa 1; RHAB. amor 2; PROP. claparèdei 1; DICT. reticulata 3; SALP. acuminata 1.

4741. 8° 29′ S.; 122° 56′ W. 11–II–'05. 80° F.

Surface: 25 loricæ counted; 28 identified; 12 spp.:

COD. apicata 8%; CDLLPS. inflata 4, parva 16, speciosa 1; EPIP. pacifica 8, undella 4; RHAB. amor 1, cornucopia 8; UND. hemispherica 4; EUT. elongatus 16, tenuis 28, tubiformis 4.

South Equatorial Current. Stations 4742, 4743, 4540

4742. 0° 3′ S.; 117° 15′ W. 15–II–'05. 77° F.

300–0 fms.: 100 loricæ counted; 176 identified; 71 spp.:

TPS. rara 1%; COD. acuta 1, amphorella 1, apicata 1, cuspidata 3 CDNR. australis 1, mucronata 2; CDLLPS. inflata 4, longa 1, meridionalis 1, minor 1, pacifica 1, parva 1, pura 1; COX. laciniosa 1 CLIM. scalaria 3; CYTT. acutiformis 1, longa 3; EPIP. blanda 4 constricta 2, deflexa 1, exquisita 1, lata 1, pacifica 4, undella 8; EPIOR alumensis 1; PET. capsa 1, major 7, pacifica 2; PROTORH. simplex 1; RHAB. amor 1, conica 5, cornucopia 1, quantula 2, spiralis 5, striata 1; RDPS. triton 2; PAR. aculeata 2, attenuata 2, difficilis 1, inflata 1, invaginata 1; XYST. treforti 1; XPS. brandti 1, cymatica 2, dahli 3, dicymatica 2, favata 2, hastata 1, heroica 1, inæqualis 1, krämeri 1, paradoxa 1, pulchra 1, tenuirostris 6; PROP. ostenfeldi 1, ovata 4, parva 2; UND. declivis 1; DICT. reticulata 1; AMPH. quadrilineata 1; ALB. agassizi 1; BDT. palliata 1; EUT. fraknóii 1, pinguis 1, tenuis 1, tubiformis 2, turgescens 7; DAT. stramonium 1; SALP. ricta 1; EPICR. prismatica 1.

800–0 fms.: 25 loricæ counted; 29 identified; 17 spp.:

COD. amphorella 1%, apicata 8; STEN. nivalis 1; CDLLPS. pacifica 4; CYTT. acutiformis 8, longa 12; EPIP. blanda 2, pacifica 4, undella 6; PET. major 20, pacifica 8; RHAB. conica 8, spiralis 1; RDPS. triton 8; PROP. ovata 4; EUT. tenuis 1, turgescens 8.

4743. 0° 21′ N.; 117° 2′ W. 15–II–'05. 78° F.

Surface: 100 loricæ counted; 106 identified; 24 spp.:

CDLLPS. minor 1%, speciosa 1; COX. laciniosa 2; CLIM. scalaria 5; CYTT. acutiformis 1; EPIP. blanda 2, deflexa 1, pacifica 15, undella 9; PET. major 4, pacifica 2; RHAB. amor 2, quantula 12, spiralis 15;

RDPS. triton 5; XYST. treforti 1; PROP. claparèdei 1, ostenfeldi 1, ovata 10; UND. ostenfeldi 1; DICT. reticulata 10; STEEN. steenstrupii 2; AMPH. quadrilineata 2; EUT. fraknóii 1.

4540. 3° 25′ N.; 115° 5′ W. 17–II–'05. 79° F.

Surface: 100 loricæ counted; 103 identified; 17 spp.:

CLIM. scalaria 12%; EPIP. pacifica 1, undella 3; EPIOR. ralumensis 1; PET. major 1, pacifica 1; RHAB. amor 1, conica 1, cornucopia 1, quantula 2, spiralis 12; RDPS. intermedia 62, longicaulis 1; XYST. treforti 1; XPS. favata 1; PROP. claparèdei 1; STEEN. steenstrupii 1.

Equatorial Counter Current. Stations 4541, 4542

4541. 4° 55′ N.; 112° 27′ W. 18–II–'05. 80° F.

Surface: 50 loricæ counted; 50 identified; 8 spp.:

CLIM. scalaria 12%; EPIP. undella 4; RHAB. conica 52, quantula 12; RDPS. triton 8; UND. hemispherica 8; DICT. reticulata 2; EUT. tenuis 2.

4542. 7° 8′ N.; 110° 45′ W. 19–II–'05. 80° F.

Surface: 20 loricæ counted; 22 identified; 12 spp.:

COD. cuspidata 5%; CDLLPS. meridionalis 5; CLIM. scalaria 10; EPIP. deflexa 5, lata 10, pacifica 25; RHAB. conica 1, quantula 1; RDPS. triton 25; PAR. caudata 5; PROP. parva 5; DICT. reticulata 5.

North Equatorial Current. Stations 4543, 4544.

4543. 8° 52′ N.; 108° 54′ W. 20–II–'05. 79° .7 F.

Surface: 50 loricæ counted; 51 identified; 14 spp.:

CDLLPS. pura 2%; CLIM. scalaria 4, scalaroides 2; PROTORH. curta 12; RHAB. amor 10, quantula 6; RDPS. triton 34; PROP. parva 2; UND. ostenfeldi 2; DICT. reticulata 1; STEEN. steenstrupii 2; AMPH. minor 2, quadrilineata 18; EUT. elongatus 4.

4544. 10° 38′ N.; 106° 47′ W. 21–II–'05. 80° F.

Surface: No Tintinnoinea.

Mexican Current. Stations 4545, 4546.

4545. 12° 42′ N.; 104° 45′ W. 22–II–'05. 79° F.

Surface: 50 loricæ counted; 68 identified; 14 spp.:

COD. cuspidata 2%; CLIM. scalaria 2; EPIP. lata 10, pacifica 4; RHAB. amor 1, conica 2, quantula 68; RDPS. triton 2; DICT. reticulata 1; STEEN. steenstrupii 1; DAD. acutiformis 2, bulbosa 2; EUT. elongatus 4, pinguis 2.

4546. 14° 50′ N.; 101° 31′ W. 23–II–'05. 81° F. Mexican Current.

Surface: 25 loricæ counted; 38 identified; 8 spp.;

CLIM. scalaria 4%; CYTT. eucecryphalus 4; EPIP. pacifica 8; RHAB. amor 16, quantula 60; PROP. claparèdei 4; AMPH. quadrilineata 4; EUT. elongatus 1.

Harbor Collections. Surface.

Panama, off Taboguilla Island and Flamenco Island.

31–X–'04. 80° F. 3 spp.:

TPS. beroidea abundant; STEN. nivalis common; MET. corbula abundant.

Panama Harbor. 25–X–'04. 8 spp.:

TPS. beroidea abundant, fennica 1, karajacensis 4, panamensis very abundant, radix 5; STEN. nivalis common; MET. corbula abundant; FAV. panamensis abundant; AMPHS. acuta 1.

Callao Harbor. 23–XI–'04. 1 spp.:

HELIC. longa 1.

Acapulco Harbor, Mexico. 26–II–'05. 83° F.

TPS. beroidea abundant; STEN. nivalis 4; FAV. panamensis 1.

DISCUSSION OF DISTRIBUTION

The records of the number of species of Tintinnoinea at the 130 record stations exhibit a diversity indicative of great contrasts in the results of the processes of speciation and adaptation in this large group of ciliate Protozoa within the area explored. These ciliates are feeders primarily on the nannoplankton composed of bacteria and the smaller Protophyta and Protozoa. The relative abundance of this plankton

in the different currents traversed is reflected in the quantity of the catch of the fine silk nets, largely composed of organisms directly or indirectly feeding upon this finer plankton.

The number of species of Tintinnoinea at the several stations bears no direct relation to the quantity of the plankton in the hauls. The quantity was noticeably greatest in the Peruvian Current but the species of the tintinnid fauna in the representative 300–0 fms. hauls were at the minimum of all ten regions, averaging 28 and ranging from 5 to 50 species per haul. On the other hand the quantity of plankton in the fine net hauls (No. 20 silk) in the South Equatorial Drift was relatively much less than in the Peruvian Current but speciation of tintinnids was at a maximum, averaging 61 and ranging from 1 to 109 species per station.

The following table summarizes the range and average number of species of tintinnids per station in hauls from surface and 300–0 fms. grouped by currents or areas. The order of relative extent of speciation in surface hauls is: — California Current, 12–50 (28) species; South Equatorial Current, 17–24 (21); Drift, 1–37 (18); Panamic Area, 3–32 (18); Mexican Current, 8–31 (16); Peruvian Current, 1–32 (11); Galapagos Eddy, 4–17 (10); Counter Equatorial Current, 8–12 (10); Easter Island Eddy, 3–14 (8); North Equatorial Current 0–14 (7); and Harbors, 1–8 (4). The small number of hauls in the line from Manga Reva to Acapulco reduces the significance of the findings in the South, North, and Counter Equatorial Currents.

RELATIVE FREQUENCY OF SPECIES AT RECORD STATIONS

	Surface			*300–0 Fms.*			*Total*		
Region	*Sta.*	*Range*	*Aver.*	*Sta.*	*Range*	*Aver.*	*Sta.*	*Range*	*Aver.*
California	5	12–50	28	4	41–65	49	9	12–65	38
Mexican Current	8	8–31	16	5	31–50	39	13	8–50	25
Peruvian Current	17	1–32	11	16	5–50	28	32	1–50	20
Panamic Area	13	3–32	18	7	6–49	32	20	3–49	22
Galapagos Eddy	2	4–17	10	2	55–84	70	5	4–85	34
Easter Island Eddy	6	3–14	8	5	30–47	40	11	3–47	23
South Equatorial Drift	22	1–37	18	24	1–109	61	46	1–109	41
South Equatorial Current	2	17–24	21	1	—	71	3	17–71	38
Equatorial Counter Current	2	8–12	10	—	—	—	2	8–12	10
North Equatorial Current	2	0–14	7	—	—	—	2	0–14	7
Harbors	4	1–8	3.8				4	1–8	3.8

The order of relative frequency in species in hauls from 300–0 fms. is South Equatorial Current, 71; Galapagos Eddy, 55–84 (70); Drift, 1–109 (61); California Current, 41–65 (49); Easter Island Eddy, 30–47 (40); Mexican Current, 31–50 (39); Panamic Area, 6–49 (32); and Peruvian Current, 5–50 (28). The differences between the patterns of distribution of the number of species in the hauls from the two levels are the resultant of many factors among which are the fertilizing chemical substances in solution, the effects of vertical migrations, the drift of surface waters as affected by wind, and the more immediate effects of light on certain of the food organisms in the nannoplankton. For these reasons the findings in hauls from 300–0 fms. may have a greater significance than in those from the surface.

There is throughout the records of numbers of species in hauls from the same or adjacent stations a noticeably greater number of species in the haul from 300–0 fms. The average number of species in 79 hauls from the surface is 16 as compared with 46 in 64 hauls from 300–0 fms. This increase of 300% is correlated with the known greater frequency of the Coccolithophoridæ at about 50 meters, and probably with the greater frequency of bacteria in the zones of decay near the light floor. The hauls from 300–0 fms. evidently fished the zone of great frequency of tintinnids. Hauls from 800–0 fms. made on the vertical wire at hydrographic stations did not show any significant difference either in number of species or in the constituent members of the fauna from those from 300–0 fms. No additions to the fauna and no significant shift in the representation of the constituent species was consistently present when the level from 800–300 fms. was added to the 300–0 fms. This is in sharp contrast to the increase in number and variety when the comparison is made between surface hauls and all those from deeper levels. Small wing nets on the trawl fishing from over 2000–0 fms. did not reveal any increase in species or any trace of an abyssal tintinnid fauna.

There is striking evidence of a very large area of great occurrence of tintinnid species crossed by Callao-Easter Island line, the Easter Island-Galapagos line, and the Galapagos-Manga Reva line above 28° S. south of the equator, and west of 90° W. The one station (4740, 300–0 fms., 54 species) extends this farther to the west, and the record of 71 species from 300–0 fms. at Sta. 4742 in the South Equatorial Current suggests its northward extension. This is one of the largest areas of least continental disturbance of oceanic conditions in all seas. It has no great amount either of bottom fauna (see Agassiz, 1906) and no great quantity of plankton such as to impede greatly the penetra-

tion of light or other forms of radiant energy. It presents an efflorescence of these ciliate Protozoa comparable to that in many other specialized groups of tropical plants and animals. Another center of abundance of species occurs in the California Current in which the number of species in hauls from 300–0 fms. increases from 41 off San Diego to 65 off Cape San Lucas.

The number of species in both surface and deeper hauls declines in the cooler waters of the Peruvian Current as the stations approach the coast. They also decline in numbers irregularly down the coast between Cape San Lucas into the Panamic Area. An even greater decline is found east of the Galapagos and north of Aguja Point. Parts at least of this Panamic Area exhibit features of impoverishment of the plankton, possibly due to exhaustion of essential nitrates and phosphates in a somewhat circumscribed region.

It is noteworthy that, although collections were made as far south as 28° S., not a single species of the Antarctic genera, Laackmanniella, Protocymatocylis, or Cymatocylis was found in the plankton. This indicates that temperature is a decisive factor in the distribution of these tintinnids and that their loricæ do not float great distances. There is, however, evidence in Gulf Stream water of invasion of at least a few species from warm seas into more northern waters. Decay of loricæ may be more rapid in the warmer tropical seas.

Throughout the station records there are many instances of the coincident occurrence in the same haul of two or more species of the same genus, both in genera with many and in those with few species. This coincidence in intermediate hauls is more evident than in surface hauls in part because there are more species present in the former, and doubtless in part because of stratification. However, the surface hauls contain abundant evidence of coincidence. There is no evidence of the isolation of geographic species and subspecies among these highly speciated genera of ciliates. Closely related species occur together consistently over wide areas. Isolation by barriers seems unnecessary as a basis for the origin of species among these ciliates. Sexual reproduction occurs among them and physiological isolation based on behavior and on structure of the body and of the lorica is possible.

SUMMARY

1. This Report deals with the Tintinnoinea of the Agassiz Expedition of the U.S.S. Albatross to the Eastern Tropical Pacific from October 6, 1904 to February 24, 1905, traversing six lines on its route

as follows: — (1) San Francisco to Panama; (2) Panama to Callao; (3) Callao to Easter Island; (4) Easter Island to the Galapagos Islands; (5) Galapagos Islands to Manga Reva; and (6) Manga Reva to Acapulco, Mexico.

2. Plankton collections were made with No. 12 and No. 20 silk nets at 130 stations *en route* and at anchorages in harbors. Hauls were variously made at these stations, at the surface at 8 P.M., from 300–0 fathoms at 8 A.M., at the hydrographic stations from 800–0 fathoms, occasionally on trawls from the bottom to the surface, and sometimes from other depths than 300 fathoms.

3. The Tintinnoinea, as a whole, have been revised on the basis of previous literature and the collections of this Expedition. The revision appears in the main in our *Conspectus* (Kofoid and Campbell, 1929), but our final conclusions and the fuller description of the Tintinnoinea of the Expedition are contained in this Report. In this revision, in its final form, we recognize 13 families and 7 subfamilies, 62 genera, 24 subgenera, and 753 species.

4. The Tintinnoinea include 13 families of which all but one, the Tintinnididæ, are represented in the collections of the Expedition. One new family, the Epiplocylidæ, is proposed in this Report, and two new subfamilies are established, Coxliellinæ and Tintinninæ, making a total of 7. To the 51 genera of our *Conspectus* (1929) we have added 9 new genera, as follows: — Codonaria, Codonopsis, Epiorella, Epicancella, Epirhabdonella, Proamphorella, Prostelidiella, Eutintinnus, and Rhabdosella (in subgeneric status; K. and C., 1929), making a total of 62 genera. Wailesia and Luminella we have described (1937) elsewhere.

Of the eight subgenera of our *Conspectus* (1929) four, Coxliella, Protocochliella, Undellopsis, and Undellicricos are retained; Epiplocylis and Salpingella (as subgenera only) are withdrawn; Epicancella and Rhabdosella are raised from subgeneric to generic rank, and 20 other new subgenera are established, viz.: — Codonelloides, Codonellopsis, Proclimacocylis, Climacocylis, Protorhabdonella, Eurhabdonella, Proxystonella, Xystonella, Spiroxystonella, Protoxystonellopsis, Proxystonellopsis, Paraxystonellopsis, Xystonelloides, Macroxystonellopsis, Xystonellopsis, Euxystonellopsis, Parundellopsis, Eutintinnus, Ceratotintinnus, and Odontotintinnus.

From the collections of the Expedition we report here 50 genera and 347 species. Of these genera 27 are new, 19 are described in our *Conspectus* (1929) and 8 in this Report. In our *Conspectus* (1929) we described 204 new species (including new names) from the collections

of the Expedition. To these we add 25 new species in this Report, making a total of 229 new species. The new species added in this Report are: — *Tintinnopsis ornata* and *rara; Coxliella fabricatrix; Climacocylis leiospiralis; Epiplocylis symmetrica; Epirhabdonella coronata* and *mucronata; Rhabdonellopsis constricta; Parundella elongata; Xystonellopsis parva, tropica,* and *turgida; Undella mammilata* and *media; Amplectella bulbosa; Undellopsis angulata* and *truncata; Dadayiella acutiformis; Salpingella incurva, laminata, sinistra,* and *tuba;* and *Epicranella bellissima, dextra,* and *magnifica.* We have described elsewhere 3 other new species, which are not in the collections but were involved in revisions, viz., *Farella thori; Undella minuta;* and *Undellopsis nuda.* The Expedition collections and the revision based thereon have increased the number of species in the Tintinnoinea by 51% over those hitherto known.

5. The confusing and complicated trinomial and quadrinomial system initiated by Brandt (1907, 1908) is uniformly reduced to a binomial system. Relationships among these species are presented by *series of species,* named after the simplest members without incorporating any new systematic category in nomenclature.

6. Morphological grounds for regarding the Tintinnoinea as a suborder of the Heterotrichida are given. They constitute the largest known suborder of the Ciliata.

7. The classification of the Tintinnoinea is based upon the comparative morphology of the lorica and the coagulated patterns of the colloidal secretions forming the substance of the wall of the lorica of the various families. The genera are founded upon the structural features of the lorica such as collar; bowl; aboral horn; circumoral channel, lip, rim and teeth; suboral nuchal constriction; longitudinal or spiral wings, fins, striæ, free lines and reticulations of the bowl; transverse or spiral laminæ, rings, and bulges on or in the collar and bowl; pedicel, knob, and canal below the bowl; and point, horn, rim, canal, and opening at the aboral end. Genera are distinguished by the addition or loss of one or more of these structural units. Species are distinguished by dimensions, proportions, and relative development or number of the structural units.

8. Evidence is presented from the comparative morphology of the lorica that there are two major regions of differentiation, the circum- and suboral region, and the aboral. Prior to the formation of the lorica the lorica-forming secretion is centered in the oral region of the anterior daughter prior to and during binary fission. When this secretion is discharged the lorica formed out of it is apparently tooled into its

specific pattern by the spiraling of the daughter animals and the definitive action of their membranelles and interpolated structures of both daughters, and probably also by the vertical lateral ciliary membrane of the anterior daughter. The anterior part of the new lorica is shaped by the anterior daughter and the aboral region by the posterior one. The lorica is thus the specific product of the differential behavior of the two schizonts in the later stages of binary fission. The rotation of the animals on their long axis provides for spiral and transverse structures of the lorica and radially arranged membranelles and longitudinal rows of cilia on the body provide for the longitudinal and steeply spiral structures of the lorica. Alveolation, reticulation, and zonation of both of these and of coccoliths, are concerned, at least in part, with the colloidal nature of the wall-forming substance, its relative rate of out-pouring during its discharge, and its mode or modes of coagulation.

9. The lorica is an adaptive structure for directed locomotion.

10. The length and diameter of the lorica vary within the species, but relatively less than the proportions. This variation exhibits rather generally among many species a correlation with temperature. The larger loricæ occur in cooler regions of the area of distribution and the smaller loricæ in the warmer ones, in approximation to Van't Hoff's law. There are exceptions to this correlation which may be due to the effects of vertical movements of water or of the individuals.

11. The tropical seas are the region of greatest evolution of the Tintinnoinea as shown both by speciation and by generic diversification. The pelagic Tintinnoinea of the tropical waters are cosmopolitan. There is little or no valid evidence of geographic boundaries or limitations of species to particular oceans. There is more evidence for limitation of species by temperature, and to comparable currents in different seas. The loricæ of the Tintinnoinea are suitable guide species for tracing the route and spread of currents.

12. There is abundant evidence of the coincident occurrence of species of the same genus in the same regions and even within the narrow limits of the uppermost meter within which the surface collections of the Expedition were taken. Isolation, if present, is not geographical but functional. There is some evidence of vertical stratification.

13. A considerable number of species are absent from or rare in surface collections and presumably belong to the fauna of deeper levels, affording opportunity for superposed stratification of faunas.

14. A relatively few species are very abundant, the great majority

of them being rare and constituting less than 2% each of the total tintinnid population. This is a corollary of the great speciation of these ciliates in tropical seas.

15. The tropical tintinnid fauna merges gradually into the subtropical and temperate, but less with reference to latitude than to the direction and flow of currents.

16. The arctic and antarctic tintinnids are largely distinct from each other. Parafavella and Ptychocylis are arctic genera and Protocymatocylis, Cymatocylis and Laackmanniella are antarctic genera. Not a single species of these distinctive genera occurred in the collections of the Expedition.

17. The Tintinnididæ and Codonellidæ are the most primitive families. In them the lorica is less definitely organized, there is more evidence of agglomeration of unshaped lorica-forming substance, more evidence of spiral structure, and less definition and characteristic modelling of the oral and aboral regions than in the higher families such as the Xystonellopsidæ and Tintinnidæ. From these basic families, especially the Codonellopsidæ, the other families radiate in various, more or less interconnected lines of differentiation.

18. The structure of the lorica affords a very satisfactory basis for a logical and natural system of classification of the tintinnids into species, genera, and families and of detecting relationships among them. A method of drawing all species to the same magnification and arranging the species in series has facilitated the systematic analysis of the suborder. Many drawings all of the same scale of individual loricæ have aided in finding the limits of intraspecific variation and bringing out diagnostic characteristics of species.

19. Species of genera, especially the larger ones, can be arranged in orthogenetic series based on morphological characters such as increase in size, progressive emergence of certain basic generic characteristics, and, in a few cases, of repetition of parts.

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New genera, subgenera, and species and the main reference are italicised

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EXPLANATION OF THE PLATES

All figures on the plates were drawn with a camera lucida from specimens in the plankton catches preserved in about 2% formalin. All drawings were made with Wolff carbon pencils on Ross board under the direction of the senior author by Mrs. Elizabeth Heald Purington except those ascribed to Miss Dorothy Harris, Miss A. L. Hamilton, Mrs. Frieda Abernathy, or Mrs. V. G. Sorrell.

PLATE 1

PLATE 1

Tintinnopsis and Codonella

Fig. 1. Lorica of *Tintinnopsis beroidea* Stein. Sta. 4627 (surface). x 336. Drawn by F. Abernathy.

Fig. 2. Lorica of *Tintinnopsis karajacensis* Bdt. Sta. 4592 (surface). x 336. Drawn by D. Harris.

Fig. 3. Lorica of *Codonella pacifica* K. and C., with section of wall cut away showing contents and closing-apparatus. Sta. 4574 (300–0 fms.). x 336.

Fig. 4. Lorica of *Tintinnopsis panamensis* K. and C. Panama Harbor (surface). x 223. Drawn by F. Abernathy.

Fig. 5. Lorica of *Codonella brevicollis* (Dad.) Bdt. Sta. 4574 (300–0 fms.). x 336.

Fig. 6. Lorica of *Codonella nationalis* Bdt. Sta. 4681 (300–0 fms.). x 223.

Fig. 7. Lorica of *Tintinnopsis rara* sp. nov. Sta. 4724 (300–0 fms.). x 336. Drawn by D. Harris.

Fig. 8. Lorica of *Tintinnopsis ornata* sp. nov., with coccoliths of *Coccolithophora wallichi*, *C. pelagica*, and *C. leptopora* on the collar and bowl. Sta. 4724 (300–0 fms.). x 720.

Fig. 9. Lorica of *Codonella rapa* K. and C. Sta. 4587 (300–0 fms.). x 223.

Fig. 10. Lorica of *Codonella pacifica* K. and C. Sta. 4680 (surface). x 336.

Fig. 11. Detail of the surface of the lorica of *Codonella diomedæ* K. and C. at the middle of the bowl of the same specimen as fig. 12. x 720.

Fig. 12. Lorica of *Codonella diomedæ* K. and C. Sta. 4681 (300–0 fms.). x 336.

Fig. 13. Detail of the collar of the same.

Fig. 14. Another lorica of *Codonella diomedæ* K. and C. Sta. 4699 (300–0 fms.). x 336.

Fig. 15. Lorica of *Codonella pacifica* K. and C. Sta. 4574 (300–0 fms.). x 336.

Fig. 16. Lorica of *Codonella elongata* K. and C. Sta. 4678 (surface). x 336. Drawn by D. Harris.

Fig. 17. Detail of the surface of the lorica of *Codonella cuspidata* K. and C. at the middle of the bowl of the same specimen as fig. 16. x 720.

Fig. 18. Lorica of the same. Sta. 4583 (300–0 fms.). x 336.

Fig. 19. Another lorica of the same. Sta. 4583 (300–0 fms.). x 336.

Fig. 20. Lorica of *Codonella aspera* K. and C. Sta. 4571 (300–0 fms.). x 336.

Fig. 21. Lorica of *Codonella cuspidata* K. and C., with coccoliths of *Calyptrosphæra oblonga* and *Umbilicosphæra mirabilis* on the surface. Sta. 4640 (300–0 fms.). x 336.

Fig. 22. Lorica of *Codonella galea* Hckl. Sta. 4583 (300–0 fms.). x 336.

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PLATE 2

PLATE 2

Codonella and Codonaria

Fig. 1. Lorica of *Codonella acuta* K. and C. Sta. 4583 (300–0 fms.). x 223.

Fig. 2. Another lorica of the same with coccoliths of *Syracosphæra apsteini* and *Coccolithophora wallichi* on the surface of the bowl. Sta. 4587 (300–0 fms.). x 336.

Fig. 3. Lorica of *Codonella tropica* K. and C. Sta. 4594 (300–0 fms.). x 336.

Fig. 4. Lorica of *Codonella acutula* K. and C., with coccoliths of *Coccolithophora leptopora*, *C. wallichi*, and *Syracosphæra pulchra* on the surface. Sta. 4640 (surface). x 336.

Fig. 5. Lorica of *Codonella acuta* K. and C. Sta. 4594 (300–0 fms.). x 223.

Fig. 6. Lorica of *Codonaria mucronata* (K. and C.). Sta. 4681 (300–0 fms.). x 223.

Fig. 7. Detail of the surface of the collar of *Codonella acuta* K. and C. of the same specimen as fig. 12. x 720.

Fig. 8. Another lorica of the same, with coccoliths of *Coccolithophora pelagica* on the middle and lower bowl, and of *Calyptrosphæra oblonga* on the upper bowl and collar. Sta. 4666 (800–0 fms.). x 720.

Fig. 9. Detail of the surface of the collar and upper part of the bowl of *Codonella galea* Hckl. Sta. 4583 (300–0 fms.). x 720.

Fig. 10. Detail of the surface of the collar of *Codonella acuta* K. and C. Sta. 4580 (300–0 fms.). x 720.

Fig. 11. Detail of the surface of the wall at the middle of the bowl of *Codonella acutula* K. and C., with coccoliths of *Coccolithophora leptopora*, *C. wallichi*, and *Syracosphæra pulchra* on the surface. Sta. 4640 (surface). x 720.

Fig. 12. Lorica of *Codonella acuta* K. and C. Sta. 4588 (surface). x 223.

Fig. 13. Lorica of *Codonaria australis* (K. and C.), with coccoliths of *Coccolithophora leptopora* on the surface of the bowl and collar and of *Pontosphæra syracusana* on the collar, and rhabdoliths of *Rhabdosphæra claviger* on the surface of the bowl. Sta. 4734 (300–0 fms.). x 336.

Fig. 14. Lorica of *Codonella amphorella* Bied. With unidentified tub-shaped coccoliths on the lower bowl, and a few of those of *Coccolithophora pelagica* sparsely distributed elsewhere. Sta. 4705 (300–0 fms.). x 720.

Fig. 15. Detail of the surface on the middle of the bowl of *Codonella tropica* K. and C. Sta. 4594 (300–0 fms.). x 720.

Fig. 16. Lorica of *Codonaria mucronata* (K. and C.). Sta. 4742 (300–0 fms.). x 336.

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PLATE 3

PLATE 3

Codonaria, Stenosemella, and Codonellopsis

Fig. 1. Lorica of *Codonellopsis cordata* K. and C., with coccoliths of *Coccolithophora wallichi* on the lower half of the bowl. Sta. 4709 (300–0 fms.). x 336.

Fig. 2. Lorica of *Codonellopsis contracta* K. and C. Sta. 4655 (300–0 fms.). x 336.

Fig. 3. Lorica of *Stenosemella nivalis* (Meun.) K. and C. Sta. 4624 (surface). x 336. Drawn by D. Harris.

Fig. 4. Lorica of *Codonellopsis turgescens* K. and C. Sta. 4583 (300–0 fms.). x 336.

Fig. 5. Lorica of *Codonellopsis contracta* K. and C. Sta. 4648 (300–0 fms.). x 336.

Fig. 6. Detail of the surface of the middle of the bowl of another lorica of the same. Sta. 4655 (300–0 fms.). x 720.

Fig. 7. Lorica of *Codonaria lata* (K. and C.). Sta. 4681 (300–0 fms.). x 720.

Fig. 8. Lorica of *Codonellopsis robusta* K. and C. Sta. 4594 (300–0 fms.). x 336.

Fig. 9. Lorica of *Codonellopsis ecaudata* (Bdt.) K. and C. Sta. 4712 (surface). x 336.

Fig. 10. Lorica of *Codonellopsis americana* K. and C. Sta. 4594 (300–0 fms.). x 336.

Fig. 11. Lorica of *Codonellopsis contracta* K. and C., with part of the wall cut away and coccoliths of Syracosphæra on the surface of the bowl. Sta. 4655 (400–0 fms.). x 720.

Fig. 12. Lorica of *Codonaria australis* (K. and C.). Sta. 4679 (300–0 fms.). x 720.

Fig. 13. Lorica of *Codonellopsis contracta* K. and C. Sta. 4655 (400–0 fms.). x 720.

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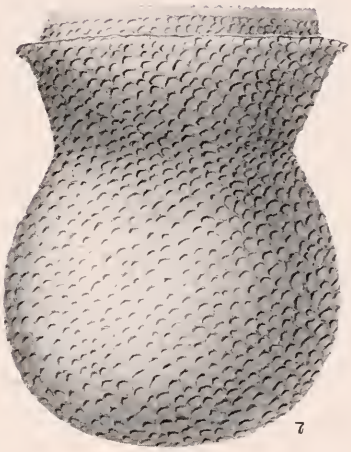

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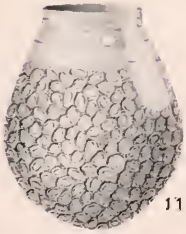

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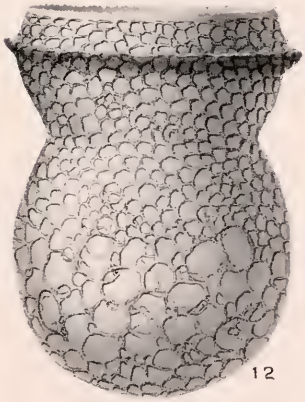

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PLATE 4

PLATE 4

Codonellopsis

Fig. 1. Lorica of *Codonellopsis pacifica* K. and C., with coccoliths of *Coccolithophora leptopora* and *Syracosphæra pulchra* on the bowl. Sta. 4732 (300–0 fms.). x 336.

Fig. 2. Lorica of *Codonellopsis minor* K. and C. Sta. 4666 (800–0 fms.). x 336.

Fig. 3. Another lorica of the same. Sta. 4634 (300–0 fms.). x 336.

Fig. 4. Another lorica of the same. Sta. 4594 (300–0 fms.). x 336.

Fig. 5. Lorica of *Codonellopsis longa* K. and C., showing coccoliths and rhabdoliths. Sta. 4724 (300–0 fms.). x 336.

Fig. 6. Lorica of *Codonellopsis pacifica* (Bdt.) K. and C. Sta. 4742 (300–0 fms.). x 336.

Fig. 7. Detail of the surface at the middle of the bowl of *Codonellopsis longa* K. and C., with coccoliths of *Umbilicosphæra mirabilis*. Sta. 4723 (surface). x 720.

Fig. 8. Lorica of *Codonellopsis turgida* K. and C. Sta. 4709 (300–0 fms.). x 336.

Fig. 9. Lorica of *Codonellopsis longa* K. and C. Sta. 4681 (300–0 fms.). x 336.

Fig. 10. Detail of the surface at the middle of the bowl of *Codonellopsis minor* K. and C., with coccoliths of *Coccolithophora leptopora*, *C. pelagica*, *Syracosphæra mediterranea*, and *Pontosphæra hæckeli*. Sta. 4666 (800–0 fms.). x 720.

Fig. 11. Detail of the surface at the middle of the bowl of the same specimen of *Codonellopsis longa* K. and C. as fig. 5, with coccoliths of *Syracosphæra pulchra* and *Coccolithophora leptopora* and rhabdoliths of *Rhabdosphæra claviger*. x 720.

Fig. 12. Lorica of *Codonellopsis pura* K. and C. Sta. 4705 (300–0 fms.). x 336.

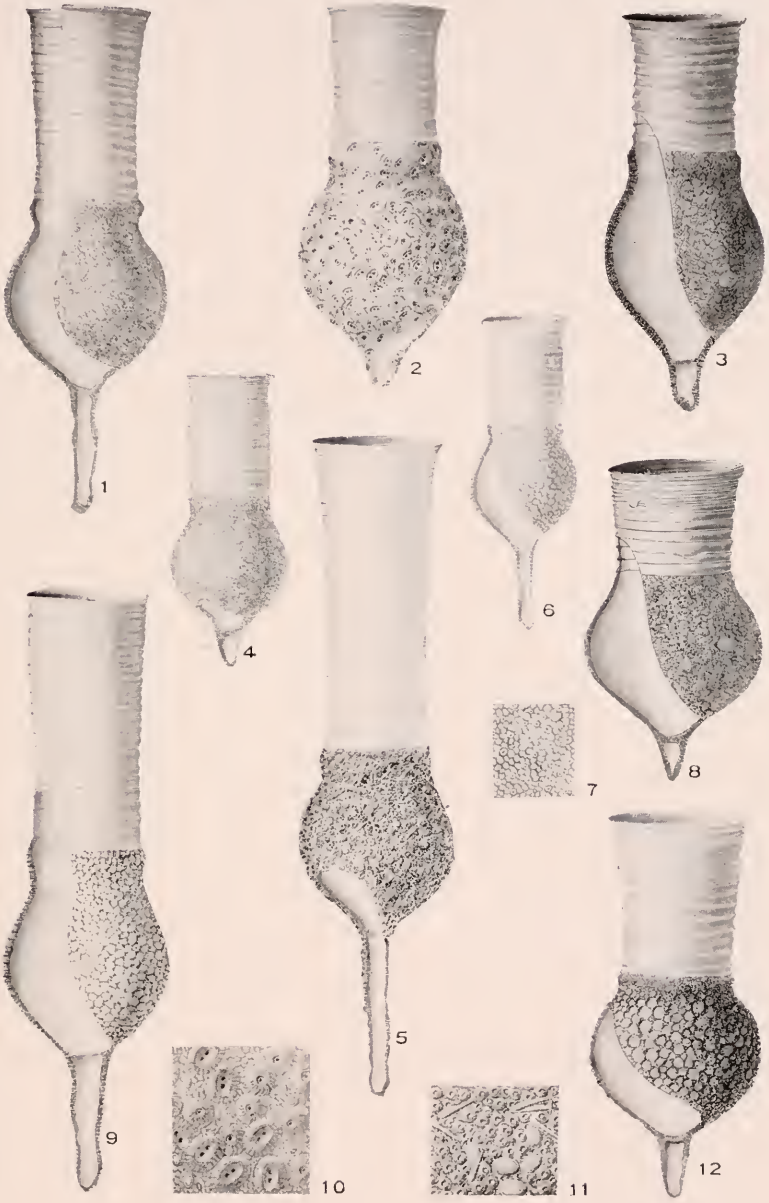
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PLATE 5

PLATE 5

Codonellopsis

Fig. 1. Lorica of *Codonellopsis tropica* K. and C. Sta. 4709 (300–0 fms.). x 336.

Fig. 2. Lorica of *Codonellopsis parva* K. and C. Sta. 4722 (300–0 fms.). x 336.

Fig. 3. Lorica of *Codonellopsis inflata* K. and C. Sta. 4709 (300–0 fms.). x 336.

Fig. 4. Lorica of *Codonellopsis californiensis* K. and C. Sta. 4587 (300–0 fms.). x 336.

Fig. 5. Detail of the surface at the middle of the bowl of *Codonellopsis parva* K. and C., with remains of coccoliths of Coccolithophora. Sta. 4741 (surface). x 720.

Fig. 6. Detail of the surface at the middle of the bowl of *Codonellopsis inflata* K. and C. Sta. 4705 (300–0 fms.). x 720.

Fig. 7. Lorica of *Codonellopsis speciosa* K. and C. Sta. 4574 (300–0 fms.). x 336.

Fig. 8. Another lorica of the same. Sta. 4709 (300–0 fms.). x 336.

Fig. 9. Lorica of *Codonellopsis meridionalis* K. and C. Sta. 4583 (300–0 fms.). x 336.

Fig. 10. Lorica of *Codonellopsis biedermanni* (Bdt.) K. and C. Sta. 4609 (300–0 fms.). x 336.

Fig. 11. Lorica of *Codonellopsis meridionalis* K. and C. Sta. 4583 (surface). x 223. Drawn by D. Harris.

Fig. 12. Lorica of *Codonellopsis inflata* K. and C. Sta. 4705 (300–0 fms.). x 336.

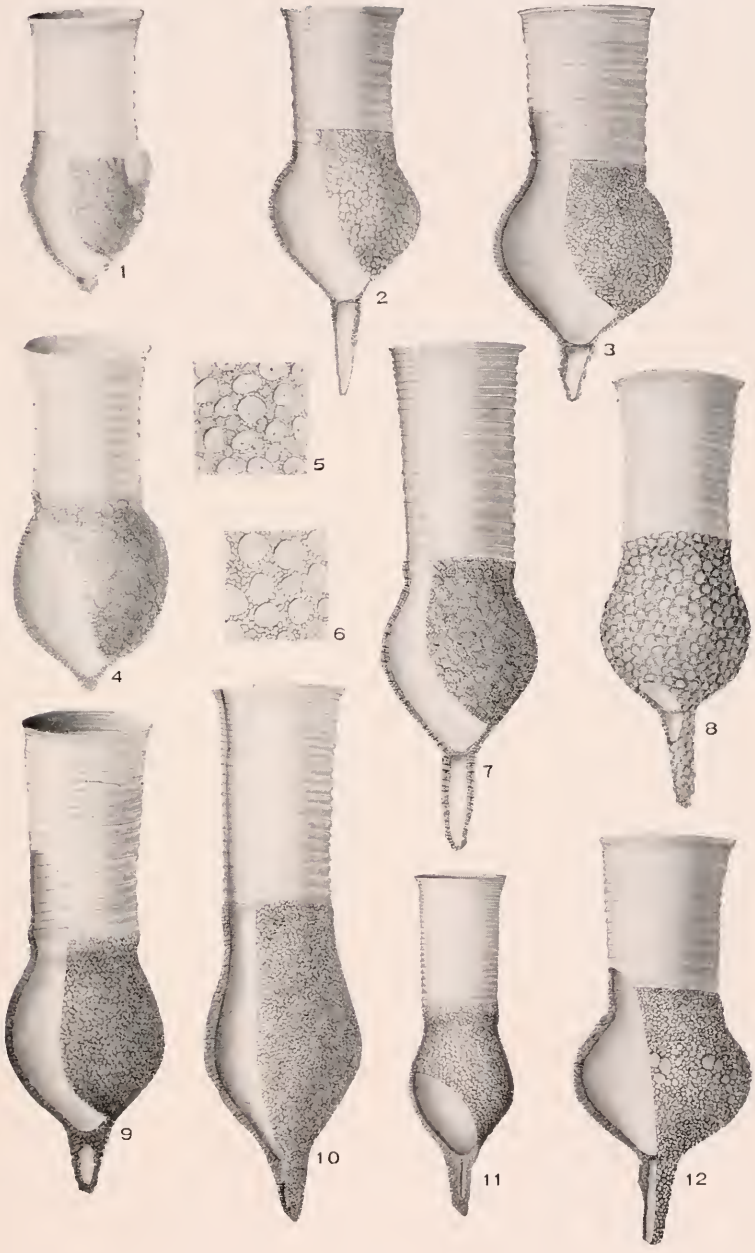
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PLATE 6

PLATE 6

Coxliella, Climacocylis, Metacylis, and Helicostomella

Fig. 1. Lorica of *Climacocylis scalaroides* K. and C., showing the irregular character of the aboral end. Sta. 4583 (surface). x 720. Drawn by F. Abernathy.

Fig. 2. Lorica of *Climacocylis sipho* (Bdt.) K. and C. Sta. 4583 (300–0 fms.). x 336. Drawn by F. Abernathy.

Fig. 3. Lorica of *Climacocylis leiospiralis* sp. nov. Sta. 4732 (800–0 fms.). x 223. Drawn by F. Abernathy.

Fig. 4. Detail of the surface of the lorica of *Climacocylis elongata* K. and C. Sta. 4571 (300–0 fms.). x 336.

Fig. 5. Lorica of *Metacylis corbula* K. and C. From near Taboguilla Island, Bay of Panama, in a surface catch. x 336.

Fig. 6. Optical section of the wall of *Climacocylis digitula* K. and C. Sta. 4583 (300–0 fms.). x 720.

Fig. 7. Lorica of *Metacylis conica* K. and C. Sta. 4580 (300–0 fms.). x 336.

Fig. 8. Lorica of *Helicostomella longa*. Sta. 4673 (300–0 fms.). x 336.

Fig. 9. Lorica of *Metacylis lucasensis* K. and C. Sta. 4583 (300–0 fms.). x 336.

Fig. 10. Lorica of *Climacocylis scalaroides* K. and C. Sta. 4619 (surface). x 336.

Fig. 11. Lorica of *Coxliella declivis* K. and C. Sta. 4576 (surface). x 223. Drawn by F. Abernathy.

Fig. 12. Lorica of *Coxliella fabricatrix* sp. nov. Sta. 4713 (300–0 fms.). x 223. Drawn by F. Abernathy.

Fig. 13. Lorica of *Climacocylis digitula* K. and C. Sta. 4583 (300–0 fms.). x 336.

Fig. 14. Detail of the surface at the oral end of *Climacocylis digitula* K. and C. Sta. 4583 (300–0 fms.). x 720.

Fig. 15. Detail of the surface of the wall of the same. x 720.

Fig. 16. Lorica of *Coxliella pelagica* K. and C. Sta. 4711 (300–0 fms.). x 336.

Fig. 17. Lorica of *Helicostomella longa* (Bdt.) K. and C. Sta. 4673 (800–0 fms.). x 720.

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PLATE 7

PLATE 7

Cyttarocylis, Porœcus, and Favella

Fig. 1. Lorica of *Cyttarocylis mucronata* K. and C. Sta. 4721 (300–0 fms.). x 336.

Fig. 2. Lorica of *Cyttarocylis eucecryphalus* (Hckl.) Kofoid. Sta. 4678 (surface). x 223.

Fig. 3. Lorica of *Favella panamensis* K. and C. From Panama Harbor in a surface catch. x 336.

Fig. 4. Lorica of *Porœcus curtus* K. and C. Sta. 4640 (surface). x 720.

Fig. 5. Lorica of *Porœcus annulatus* K. and C., with coccoliths of *Coccolithophora leptopora* and *C. pelagica* on the surface. Sta. 4707 (300–0 fms.). x 336.

Fig. 6. Lorica of *Cyttarocylis magna* Hckl. Sta. 4679 (300–0 fms.). x 223. Drawn by D. Harris.

Fig. 7. Lorica of *Porœcus apicatus* K. and C. Sta. 4732 (800–0 fms.). x 336.

Fig. 8. Lorica of *Cyttarocylis brandti* K. and C. Sta. 4737 (300–0 fms.). x 223.

Fig. 9. Lorica of *Favella azorica* (Cl.) Jörg. Sta. 4694 (surface). x 336.

Fig. 10. Detail of the surface of the lorica at the oral end of the bowl of *Porœcus curtus* K. and C., showing reticulations. Sta. 4648 (300–0 fms.). x 720.

Fig. 11. Lorica of *Porœcus curtus* K. and C., with coccoliths of *Coccolithophora leptopora* and *C. pelagica* on the surface. Sta. 4648 (300–0 fms.). x 720.

Fig. 12. Another lorica of the same. Sta. 4637 (300–0 fms.). x 720. Drawn by D. Harris.

Fig. 13. Another lorica of the same. Sta. 4713 (300–0 fms.). x 720.

Fig. 14. Lorica of *Porœcus apiculatus* K. and C., with coccoliths of *Coccolithophora leptopora*, *Syracosphæra pulchra*, and *Umbilicosphæra mirabilis* on the surface. Sta. 4724 (300–0 fms.). x 720.

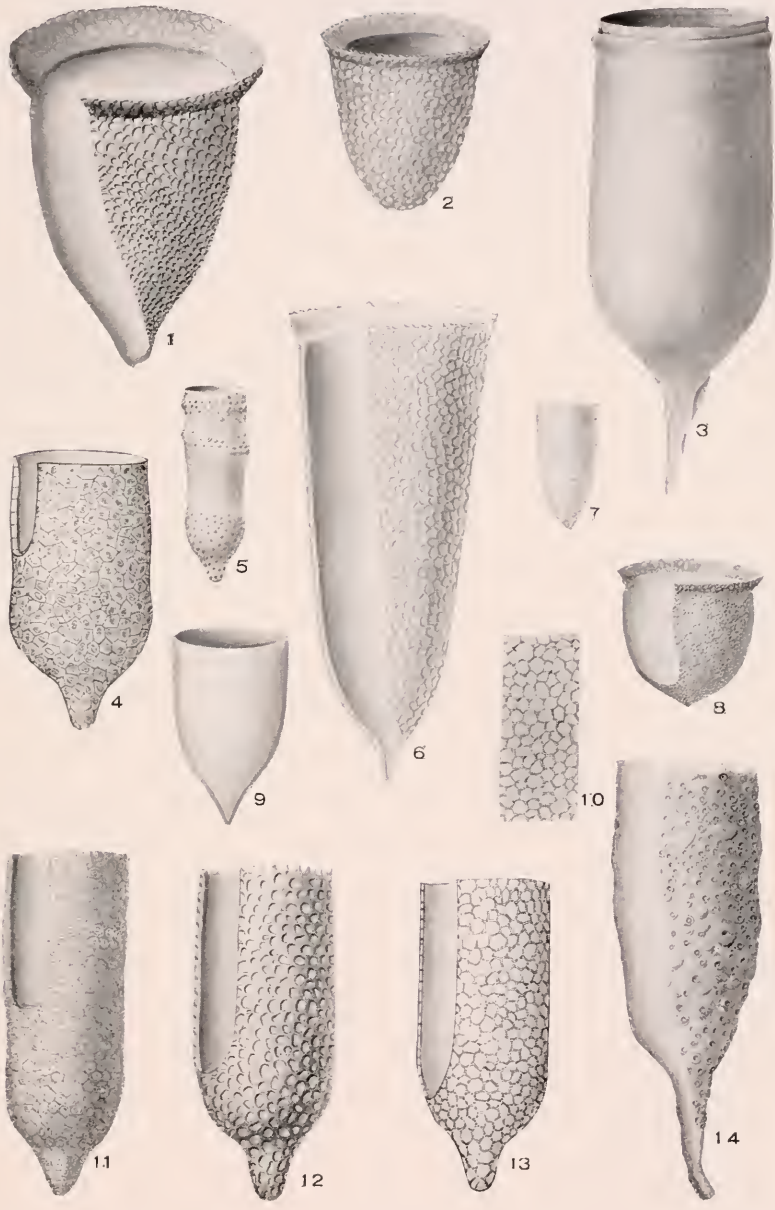
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PLATE 8

PLATE 8

Epiorella and Epiplocylis

Fig. 1. Lorica of *Epiplocylis sargassensis* (Bdt.) K. and C. Sta. 4737 (300–0 fms.). x 336.

Fig. 2. Lorica of *Epiorella acuta* (K. and C.). Sta. 4669 (surface). x 223.

Fig. 3. Lorica of *Epiplocylis symmetrica* sp. nov. Sta. 4576 (surface). x 336.

Fig. 4. Lorica of *Epiorella ralumensis* (Bdt.) K. and C. Sta. 4737 (550–0 fms.). x 223.

Fig. 5. Lorica of *Epiplocylis blanda* Jörg. Sta. 4583 (surface). x 336.

Fig. 6. Lorica of *Epiplocylis sargassensis* (Bdt.) K. and C. Sta. 4721 (300–0 fms.). x 223.

Fig. 7. Lorica of *Epiorella curta* (K. and C.). Sta. 4673 (300–0 fms.). x 720.

Fig. 8. Another lorica of the same. Sta. 4655 (400–0 fms.). x 336.

Fig. 9. Lorica of *Epiorella acuta* (K. and C.). Sta. 4715 (300–0 fms.). x 223.

Fig. 10. Lorica of *Epiorella ralumensis* (Bdt.) K. and C. Sta. 4728 (300–0 fms.). x 223.

Fig. 11. Lorica of *Epiorella acuta* (K. and C.). Sta. 4648 (300–0 fms.). x 720.

Fig. 12. Lorica of *Epiorella healdi* (K. and C.). Sta. 4644 (300–0 fms.). x 223.

Fig. 13. Another lorica of the same. Sta. 4650 (300–0 fms.). x 223.

Fig. 14. Another lorica of the same. Sta. 4675 (300–0 fms.). x 720.

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PLATE 9

PLATE 9

Epiplocylis

Fig. 1. Lorica of *Epiplocylis undella* (Ost. and Schm.) Jörgensen. Sta. 4580 (300–0 fms.). x 223. Drawn by D. Harris.

Fig. 2. Another lorica of the same. Sta. 4607 (surface). x 223.

Fig. 3. Lorica of *Epiplocylis impensa* K. and C. Sta. 4576 (surface). x 223. Drawn by F. Abernathy.

Fig. 4. Abnormal lorica of *Epiplocylis undella* (Ost. and Schm.) Jörg. Sta. 4580 (surface). x 223.

Fig. 5. Lorica of *Epiplocylis exquisita* K. and C. Sta. 4697 (300–0 fms.). x 223.

Fig. 6. Lorica of *Epiplocylis lata* K. and C. Sta. 4717 (300–0 fms.). x 720.

Fig. 7. Lorica of *Epiplocylis undella* (Ost. and Schm.) Jörg. Sta. 4607 (surface). x 223. Drawn by D. Harris.

Fig. 8. Lorica of *Epiplocylis exigua* K. and C. Sta. 4683 (300–0 fms.). x 336.

Fig. 9. Lorica of *Epiplocylis lata* K. and C. Sta. 4717 (300–0 fms.). x 336.

Fig. 10. Lorica of *Epiplocylis undella* (Ost. and Schm.) Jörg. Sta. 4580 (surface). x 336.

Fig. 11. Lorica of *Epiplocylis exigua* K. and C. Sta. 4683 (300–0 fms.). x 720.

Fig. 12. Lorica of *Epiplocylis exquisita* K. and C. Sta. 4580 (300–0 fms.). x 336.

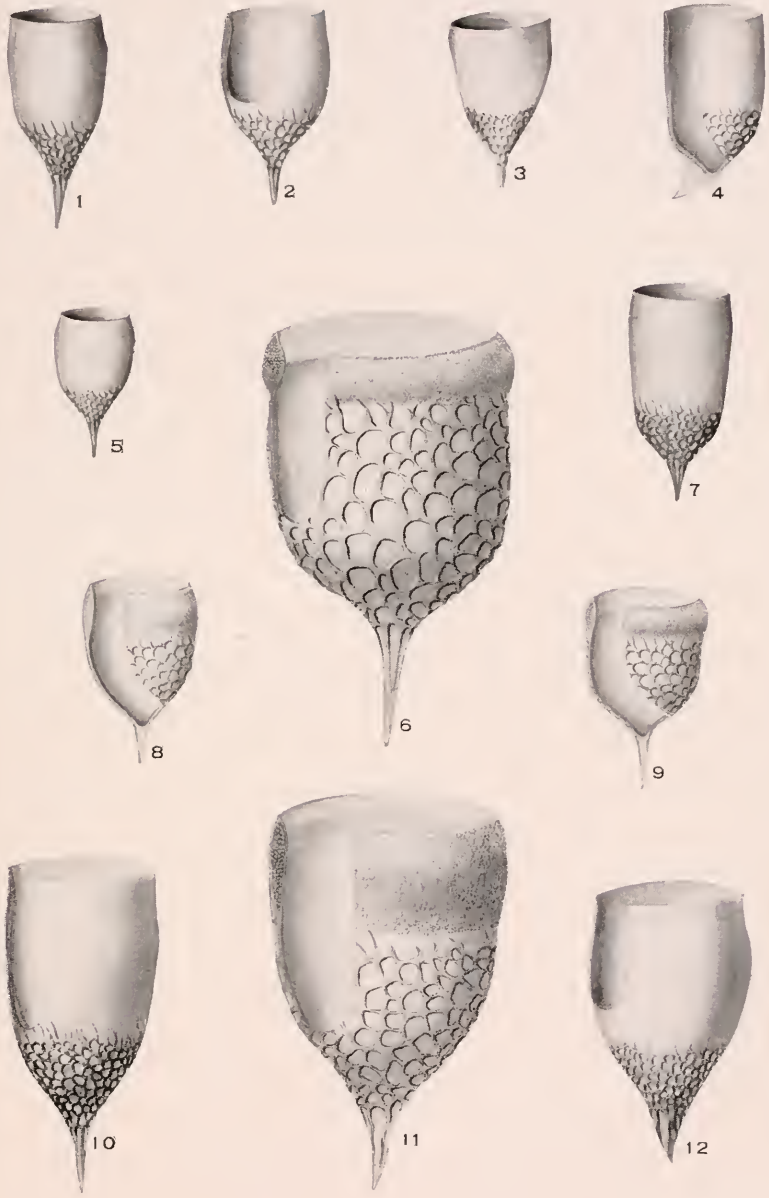
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PLATE 10

PLATE 10

Epiplocylis and Epicancella

Fig. 1. Lorica of *Epiplocylis constricta* K. and C. Sta. 4583 (300–0 fms.). x 336.

Fig. 2. Another lorica of the same. Sta. 4698 (surface). x 336.

Fig. 3. Another lorica of the same. Sta. 4639 (surface). x 223.

Fig. 4. Lorica of *Epicancella nervosa* (Cl.) K. and C. Sta. 4678 (surface). x 720.

Fig. 5. Lorica of *Epiplocylis deflexa* K. and C. Sta. 4503 (surface). x 336.

Fig. 6. Lorica of *Epiplocylis constricta* K. and C. Sta. 4580 (surface). x 336.

Fig. 7. Lorica of *Epiplocylis deflexa* K. and C., showing a cyst. Sta. 4583 (300–0 fms.). x 336.

Fig. 8. Lorica of *Epiplocylis pacifica* K. and C. Sta. 4594 (300–0 fms.). x 336.

Fig. 9. Another lorica of the same. Sta. 4580 (300–0 fms.). x 336.

Fig. 10. Lorica of *Epiplocylis deflexa* K. and C. Sta. 4609 (300–0 fms.). x 336.

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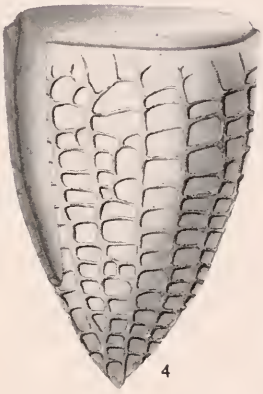
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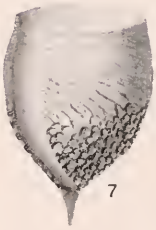
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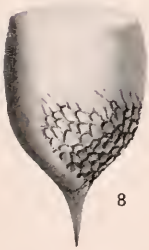
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PLATE 11

PLATE 11

Craterella, Acanthostomella, and Petalotricha

Fig. 1. Lorica of *Acanthostomella minutissima* K. and C. Sta. 4711 (300–0 fms.). x 720.

Fig. 2. Oral end of the lorica of *Petalotricha foli* K. and C. Sta. 4666 (800–0 fms.). x 336.

Fig. 3. Lorica of *Acanthostomella obtusa* K. and C. Sta. 4634 (300–0 fms.). x 720.

Fig. 4. Lorica of *Acanthostomella minutissima* K. and C. Sta. 4666 (surface). x 336.

Fig. 5. Another lorica of the same, with coccoliths of *Coccolithophora leptopora* on its surface. Sta. 4675 (300–0 fms.). x 336.

Fig. 6. Another lorica of the same with coccoliths of *Coccolithophora leptopora* on its surface. Sta. 4666 (surface). x 720.

Fig. 7. Lorica of *Craterella armilla* K. and C. Sta. 4718 (surface). x 720.

Fig. 8. Lorica of *Petalotricha foli* K. and C. Sta. 4659 (surface). x 336.

Fig. 9. Lorica of *Acanthostomella conicoides* K. and C. Sta. 4724 (300–0 fms.). x 336.

Fig. 10. Lorica of *Craterella armilla* K. and C. Sta. 4713 (300–0 fms.). x 336.

Fig. 11. Lorica of *Petalotricha pacifica* K. and C. Sta. 4734 (300–0 fms.). x 223.

Fig. 12. Lorica of *Acanthostomella obtusa* K. and C. Sta. 4646 (300–0 fms.). x 336.

Fig. 13. Lorica of *Acanthostomella minutissima* K. and C. Sta. 4675 (300–0 fms.). x 336.

Fig. 14. Lorica of *Craterella armilla* K. and C. Sta. 4724 (300–0 fms.). x 720.

Fig. 15. Lorica of *Petalotricha pacifica* K. and C. Sta. 4574 (300–0 fms.). x 223.

Fig. 16. Lorica of *Craterella protuberans* K. and C. Sta. 4705 (2031–0 fms.). x 336.

Fig. 17. Lorica of *Craterella urccolata* (Ost.) K. and C. Sta. 4664 (300–0 fms.). x 336.

Fig. 18. Lorica of *Petalotricha capsa* Bdt. Sta. 4590 (300–0 fms.). x 223.

Fig. 19. Lorica of *Petalotricha major* Jörg. Sta. 4734 (300–0 fms.). x 336.

Fig. 20. Lorica of *Acanthostomella lata* K. and C. Sta. 4724 (300–0 fms.). x 720.

Fig. 21. Lorica of *Petalotricha pacifica* K. and C. Sta. 4742 (300–0 fms.). x 336.

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PLATE 12

PLATE 12

Protorhabdonella, Epirhabdonella, and Rhabdonella

Fig. 1. Lorica of *Rhabdonella cornucopia* K. and C. Sta. 4583 (300–0 fms.). x 336.

Fig. 2. Lorica of *Protorhabdonella curta* (Cl.) Jörg. Sta. 4583 (surface). x 336.

Fig. 3. Lorica of *Protorhabdonella simplex* (Cl.) Jörg., with coccoliths of Coccolithophora and Syracosphæra on the surface. Sta. 4574 (surface). x 720.

Fig. 4. Lorica of *Rhabdonella exilis* K. and C. Sta. 4721 (300–0 fms.). x 336.

Fig. 5. Lorica of *Rhabdonella amor* (Cl.) Bdt. Sta. 4718 (surface). x 336.

Fig. 6. Lorica of *Protorhabdonella striatura* K. and C. Sta. 4666 (surface). x 336.

Fig. 7. Oral and interior view of a lorica of *Protorhabdonella curta* (Cl.) Jörg. Sta. 4683 (300–0 fms.). x 336.

Fig. 8. Lorica of *Epirhabdonella coronata* sp. nov. Sta. 4704 (surface). x 720.

Fig. 9. Aboral view of another lorica of the same. Sta. 4576 (surface). x 336.

Fig. 10. Lorica of *Protorhabdonella mira* K. and C. Sta. 4701 (800–0 fms.). x 336.

Fig. 11. Lorica of *Rhabdonella poculum* (Ost. and Schm.) Brandt. Sta. 4640 (surface). x 720.

Fig. 12. Detail of the wall at the oral end of *Rhabdonella cornucopia* K. and C. Sta. 4583 (300–0 fms.). x 720.

Fig. 13. Lorica of *Epirhabdonella mucronata* sp. nov. Sta. 4576 (surface). x 336.

Fig. 14. Another lorica of the same from the same station. x 336.

Fig. 15. Lorica of *Rhabdonella indica* Laack. Sta. 4721 (300–0 fms.). x 720.

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PLATE **13**

PLATE 13

Rhabdonella

Fig. 1. Lorica of *Rhabdonella henseni* (Bdt.) Bdt. Sta. 4675 (300–0 fms.). x 223.

Fig. 2. Lorica of *Rhabdonella quantula* K. and C. Sta. 4583 (300–0 fms.). x 336.

Fig. 3. Another lorica of the same. Sta. 4604 (surface). x 336.

Fig. 4. Lorica of *Rhabdonella torta* K. and C. Sta. 4721 (300–0 fms.). x 336.

Fig. 5. Optical section of the wall of the same lorica at the oral end. x 720.

Fig. 6. Detail of the surface of the bowl of the same lorica, showing ribs and fenestræ. Sta. 4721 (surface). x 720.

Fig. 7. Lorica of *Rhabdonella hebe* (Cl.) Bdt. Sta. 4571 (surface). x 336.

Fig. 8. Aboral region of the lorica of the same. Sta. 4576 (surface). x 336.

Fig. 9. Aboral region of another lorica of the same. Sta. 4583 (surface). x 720.

Fig. 10. Lorica of *Rhabdonella striata* (Bied.) Bdt. Sta. 4571 (surface). x 336.

Fig. 11. Optical section of a deformed pedicel of *Rhabdonella hebe* (Cl.). Sta. 4571 (surface). x 336.

Fig. 12. Optical section of another lorica of the same. Sta. 4583 (surface). x 720.

Fig. 13. Lorica of *Rhabdonella valdestriata* Bdt. Sta. 4580 (surface). x 336.

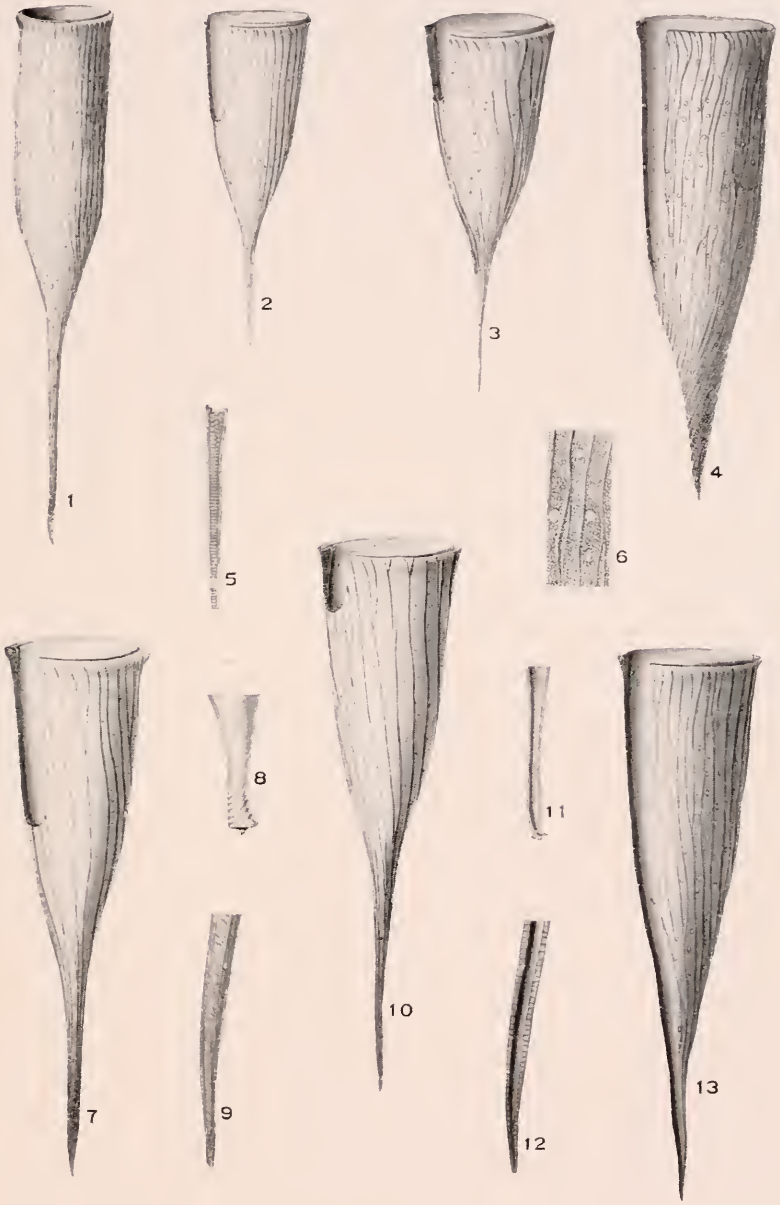
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PLATE **14**

PLATE 14

Rhabdonella and Rhabdonellopsis

Fig. 1. Optical section of the pedicel and knob of *Rhabdonellopsis minima* K. and C. Sta. 4703 (300–0 fms.). x 720.

Fig. 2. Lorica of *Rhabdonella conica* K. and C. Sta. 4571 (surface). x 336.

Fig. 3. Surface view of the pedicel and knob of *Rhabdonellopsis minima* K. and C. Sta. 4703 (300–0 fms.). x 720.

Fig. 4. Lorica of *Rhabdonella inflata* K. and C. Sta. 4676 (300–0 fms.). x 336.

Fig. 5. Optical section of the pedicel and lance of *Rhabdonellopsis minima* K. and C. Sta. 4763 (300–0 fms.). x 720.

Fig. 6. Optical section of the wall of the oral end of *Rhabdonella lohmanni* K. and C. Sta. 4679 (300–0 fms.). x 336.

Fig. 7. Lorica of *Rhabdonella aberrans* K. and C. Sta. 4580 (surface). x 336.

Fig. 8. Aboral region of *Rhabdonella chiliensis* K. and C. Sta. 4670 (800–0 fms.). x 720.

Fig. 9. Lorica of *Rhabdonella lohmanni* K. and C. Sta. 4679 (300–0 fms.). x 336.

Fig. 10. Aboral region of *Rhabdonella conica* K. and C. Sta. 4583 (surface). x 720.

Fig. 11. Lorica of *Rhabdonella conica* K. and C. Sta. 4541 (surface). x 336.

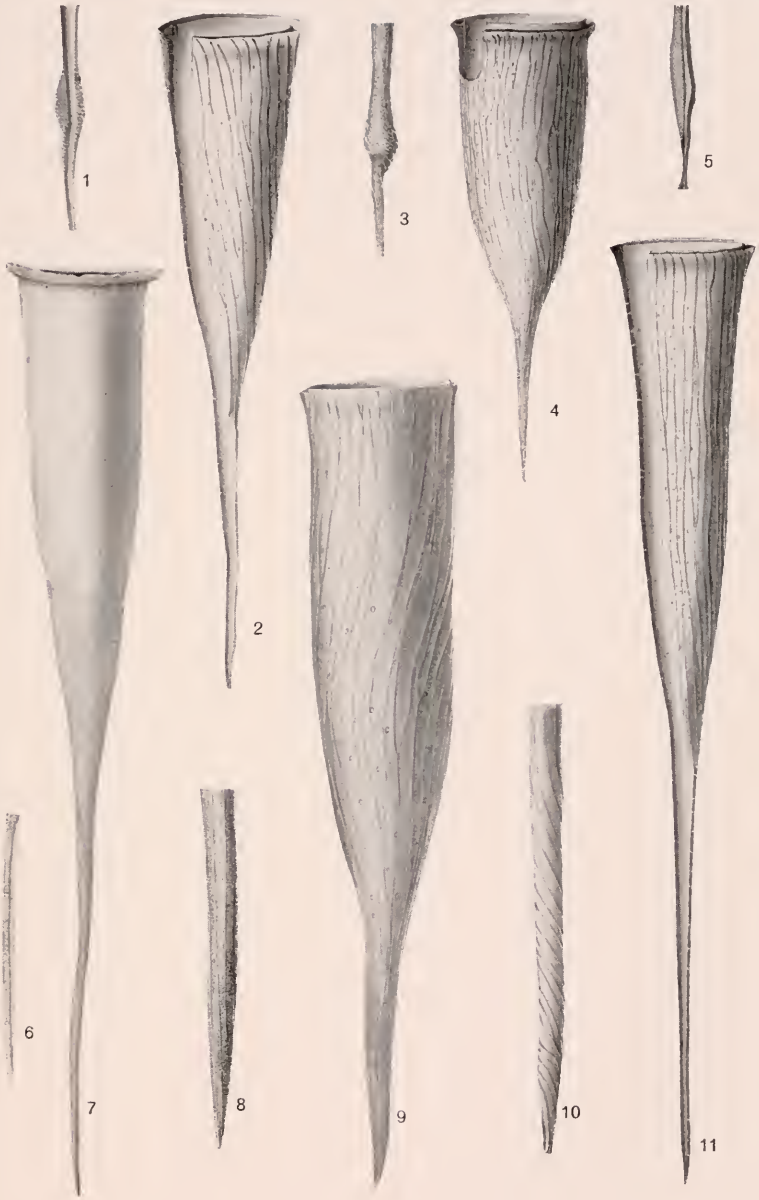
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PLATE 15

PLATE 15

Rhabdonella and Rhabdonellopsis

Fig. 1. Optical section of the pedicel, knob, and lance of *Rhabdonellopsis minima* K. and C. Sta. 4703 (300–0 fms.). x 720.

Fig. 2. Lorica of *Rhabdonellopsis constricta* sp. nov. Sta. 4712 (surface). x 336.

Fig. 3. Lorica of *Rhabdonella cuspidata* (Zach.) Bdt. Sta. 4624 (surface). x 336.

Fig. 4. Aboral end of the same lorica. x 720.

Fig. 5. Optical section of the aboral end of the same lorica. x 720.

Fig. 6. Lorica of *Rhabdonella spiralis* (Fol) Bdt. Sta. 4743 (surface). x 336.

Fig. 7. Optical section of the wall of the oral end of *Rhabdonellopsis minima* K. and C. Sta. 4712 (surface). x 720.

Fig. 8. Pedicel and knob of another lorica of the same. Sta. 4703 (300–0 fms.). x 720.

Fig. 9. Pedicel and knob of another lorica of the same. Sta. 4712 (surface). x 720.

Fig. 10. Optical section of the aboral region of *Rhabdonella chiliensis* K. and C. Sta. 4670 (800–0 fms.). x 720.

Fig. 11. Lorica of *Rhabdonellopsis minima* K. and C. Sta. 4703 (300–0 fms.). x 336.

Fig. 12. Detail of the wall of the same lorica. x 720.

Fig. 13. Detail of the wall of another lorica of the same. Sta. 4690 (surface). x 720.

Fig. 14. Another lorica of the same. Sta. 4690 (surface). x 336.

Fig. 15. Detail of the wall of another lorica of the same. Sta. 4683 (surface). x 720.

Fig. 16. Lorica of *Rhabdonella chiliensis* K. and C. Sta. 4670 (800–0 fms.). x 336.

Fig. 17. Detail from the surface of the bowl of the same lorica, showing the prismatic structure. x 720.

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PLATE 16

PLATE 16

Rhabdonellopsis

Fig. 1. Pedicel and knob of *Rhabdonellopsis intermedia* K. and C. Sta. 4583 (300–0 fms.). x 223.

Fig. 2. Lorica of *Rhabdonellopsis triton* (Zach.) K. and C. Sta. 4659 (surface). x 336.

Fig. 3. Pedicel and knob of another lorica of the same. Sta. 4665 (surface). x 720.

Fig. 4. Lorica of *Rhabdonellopsis longicaulis* K. and C. Sta. 4736 (300–0 fms.). x 336.

Fig. 5. Optical section of the wall of the anterior end of another lorica of the same. Sta. 4678 (surface). x 720.

Fig. 6. Knob and lance of *Rhabdonellopsis triton* (Zach.) K. and C. Sta. 4659 (surface). x 720.

Fig. 7. Knob and lance of *Rhabdonellopsis longicaulis* K. and C. Sta. 4678 (surface). x 720.

Fig. 8. Detail of the surface of the bowl of another lorica of the same, showing ribs and fenestræ. Sta. 4736 (300–0 fms.). x 720.

Fig. 9. Knob and lance of another lorica of the same. Sta. 4736 (300–0 fms.). x 720.

Fig. 10. Detail of the surface of the bowl of *Rhabdonellopsis triton* (Zach.) K. and C. Sta. 4659 (surface). x 720.

Fig. 11. Optical section of the knob and lance of another lorica of *Rhabdonellopsis longicaulis* K. and C. Sta. 4736 (300–0 fms.). x 720.

Fig. 12. Detail of the surface of the bowl of another lorica of the same, showing ribs and fenestræ. Sta. 4678 (surface). x 720.

Fig. 13. Knob and lance of another lorica of the same. Sta. 4678 (surface). x 720.

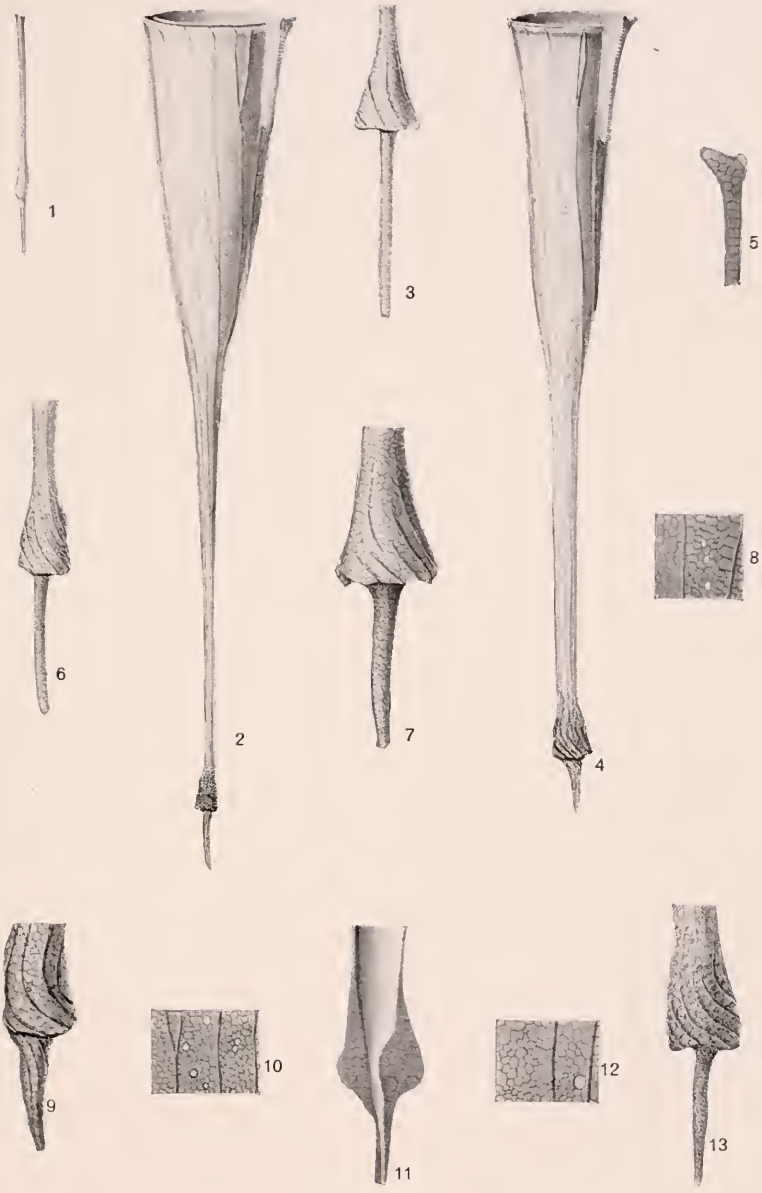
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PLATE 17

PLATE 17

Rhabdonellopsis and Parundella

Fig. 1. Lorica of *Rhabdonellopsis triton* (Zach.) K. and C. Sta. 4665 (surface). x 223.

Fig. 2. Another lorica of the same. Sta. 4665 (surface). x 223.

Fig. 3. Lorica of *Rhabdonellopsis longicaulis* K. and C. Sta. 4678 (surface). x 336.

Fig. 4. Lorica of *Rhabdonellopsis triton* (Zach.) K. and C. Sta. 4659 (surface). x 223.

Fig. 5. Lorica of *Rhabdonellopsis intermedia* K. and C. Sta. 4583 (surface). x 336.

Fig. 6. Pedicel and knob of another lorica of the same. Sta. 4583 (300–0 fms.). x 720.

Fig. 7. Optical section of the oral end of the lorica of *Parundella inflata* K. and C. Sta. 4697 (300–0 fms.). x 720.

Fig. 8. Pedicel and knob of the lorica of *Rhabdonellopsis intermedia* K. and C. Sta. 4583 (300–0 fms.). x 720.

Fig. 9. Lorica of *Parundella elongata* sp. nov. Sta. 4659 (surface). x 223.

Fig. 10. Optical section of the wall of the oral end of the lorica of *Rhabdonellopsis intermedia* K. and C. Sta. 4583 (300–0 fms.). x 720.

Fig. 11. Lorica of *Parundella inflata* K. and C. Sta. 4699 (300–0 fms.). x 336.

Fig. 12. Lorica of *Parundella aculeata* Jörg. Sta. 4701 (300–0 fms.). x 336.

Fig. 13. Lorica of *Parundella prætenuis* K. and C. Sta. 4646 (300–0 fms.). x 336.

Fig. 14. Lorica of *Parundella humerosa* K. and C. Sta. 4646 (300–0 fms.). x 336.

Fig. 15. Another lorica of the same. Sta. 4701 (300–0 fms.). x 336.

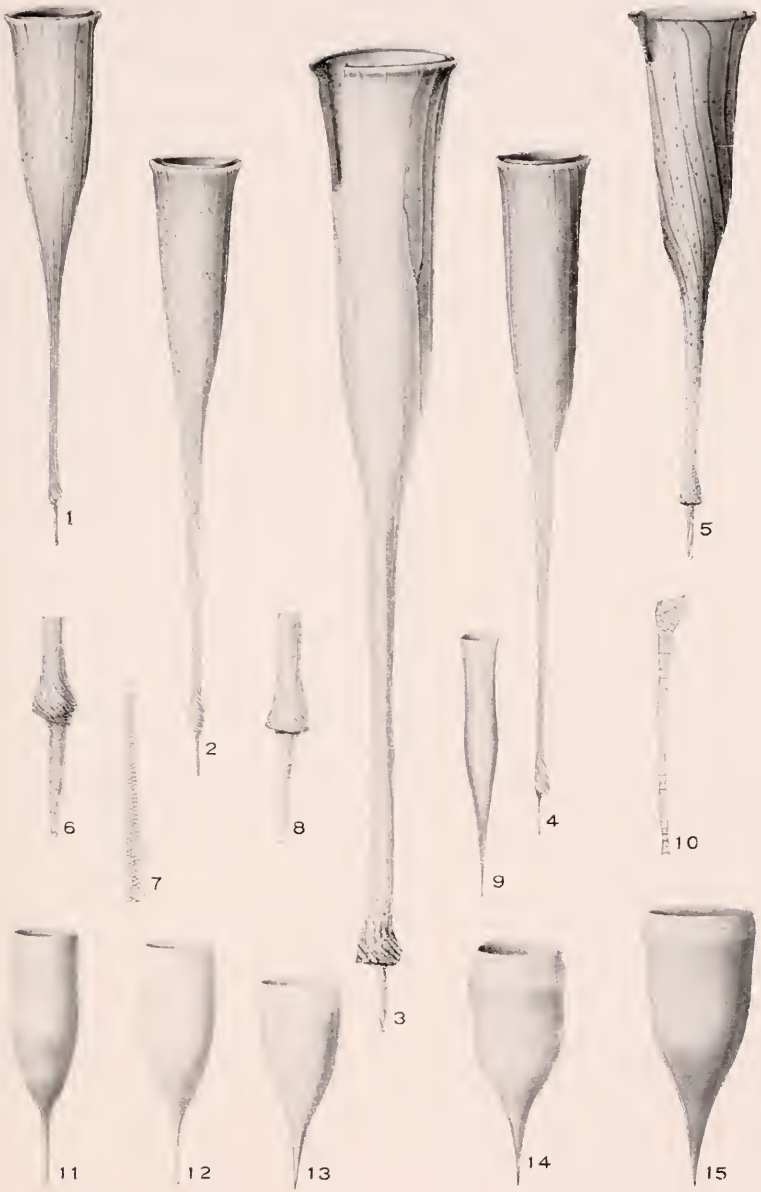
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PLATE 18

PLATE 18

Parundella and Xystonellopsis

Fig. 1. Lorica of *Parundella clavus* K. and C. Sta. 4697 (300–0 fms.). x 336.

Fig. 2. Lorica of *Xystonellopsis turgida* sp. nov. Sta. 4734 (300–0 fms.). x 336.

Fig. 3. Aboral end of the same lorica. x 720.

Fig. 4. Lorica of *Parundella invaginata* K. and C. Sta. 4634 (300–0 fms.). x 336.

Fig. 5. Lorica of *Xystonellopsis epigrus* K. and C. Sta. 4734 (300–0 fms.). x 336.

Fig. 6. Lorica of *Parundella acuta* K. and C. Sta. 4713 (300–0 fms.). x 336.

Fig. 7. Optical section of the wall of the oral region of the lorica of *Parundella gigantea* K. and C. Sta. 4713 (300–0 fms.). x 720.

Fig. 8. Lorica of *Parundella acuta* K. and C., cut to show optical section of wall. Sta. 4713 (300–0 fms.). x 720.

Fig. 9. Aboral region of lorica of *Xystonellopsis epigrus* K. and C. Sta. 4734 (300–0 fms.). x 720.

Fig. 10. Aboral region of the lorica of *Parundella clavus* K. and C. Sta. 4724 (300–0 fms.). x 720.

Fig. 11. Optical section of the wall of the anterior end of *Parundella humerosa* K. and C. Sta. 4655 (400–0 fms.). x 720.

Fig. 12. Optical section of the oral region of the wall of *Parundella aciculifera* (Jörg.) K. and C. Sta. 4701 (300–0 fms.). x 720.

Fig. 13. Detail of the surface of the wall of *Parundella difficilis* K. and C. Sta. 4724 (300–0 fms.). x 336.

Fig. 14. Optical section of the aboral region of *Xystonellopsis epigrus* K. and C. Sta. 4734 (300–0 fms.). x 720.

Fig. 15. Lorica of *Parundella messinensis* (Bdt.) Jörg. Sta. 4683 (300–0 fms.). x 336.

Fig. 16. Lorica of *Parundella aciculifera* (Jörg.). Sta. 4605 (300–0 fms.). x 336.

Fig. 17. Lorica of *Parundella difficilis* K. and C. Sta. 4724 (300–0 fms.). x 336.

Fig. 18. Lorica of *Parundella gigantea* K. and C. Sta. 4713 (300–0 fms.). x 336.

Fig. 19. Lorica of *Parundella attenuata* K. and C. Sta. 4713 (300–0 fms.). x 336.

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PLATE 19

PLATE 19

Xystonella and Xystonellopsis

Fig. 1. Lorica of *Xystonella longicauda* (Bdt.) Bdt. Sta. 4682 (surface). x 336.

Fig. 2. Lorica of *Xystonella treforti* (Dad.) Laack. Sta. 4687 (300–0 fms.). x 336.

Fig. 3. Optical section of the wall from the middle of the bowl of the same lorica. x 720.

Fig. 4. Detail from the surface at the oral end of the bowl of the same lorica. x 720.

Fig. 5. Detail from the surface at the middle of the bowl of the same lorica. x 720.

Fig. 6. Optical section of the wall at the oral end of *Xystonellopsis conicacauda* K. and C. Sta. 4701 (300–0 fms.). x 720.

Fig. 7. Detail of the knob and lance of the same lorica of *Xystonella treforti* (Dad.) Laack. as Fig. 2. x 720.

Fig. 8. Lorica of *Xystonella minuscula* K. and C. Sta. 4659 (surface). x 336.

Fig. 9. Pedicel and lance of the lorica of *Xystonella longicauda*. (Bdt.) Bdt. Sta. 4571 (surface). x 720.

Fig. 10. Lorica of *Xystonellopsis conicacauda* K. and C. Sta. 4734 (300–0 fms.). x 336.

Fig. 11. Optical section of the aboral end of *Xystonella clavata* Jörg. Sta. 4701 (300–0 fms.). x 336.

Fig. 12. Optical section of the aboral end of another lorica of *Xystonellopsis conicacauda* K. and C. Sta. 4701 (300–0 fms.). x 720.

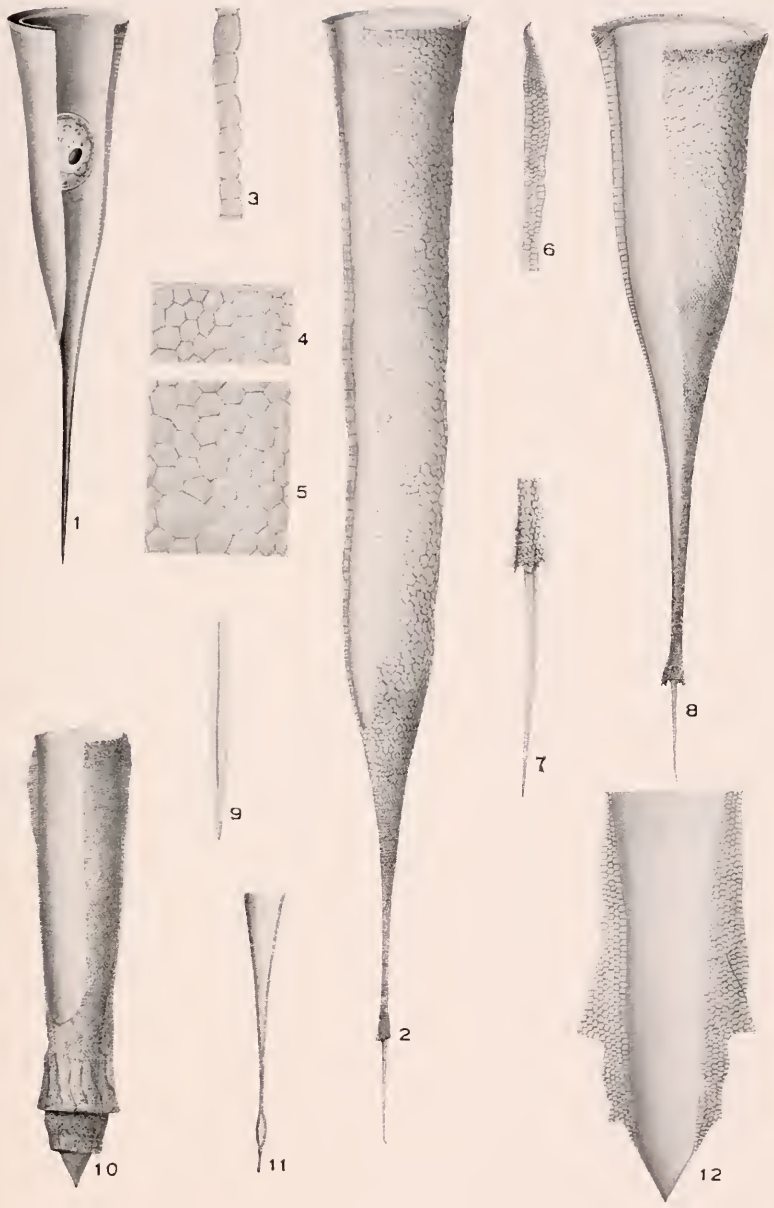
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PLATE 20

PLATE 20

Parundella, Xystonella, and Xystonellopsis

Fig. 1. Knob and lance of the lorica of *Xystonella minuscula* K. and C. Sta. 4676 (300–0 fms.). x 720.

Fig. 2. Knob and lance of another lorica of the same. Sta. 4659 (surface). x 720.

Fig. 3. Knob and lance of another lorica of the same. Sta. 4675 (surface). x 720.

Fig. 4. Knob and lance of another lorica of the same. Sta. 4675 (surface). x 720.

Fig. 5. Knob and lance of another lorica of the same. Sta. 4676 (300–0 fms.). x 720.

Fig. 6. Optical section of the knob and lance of lorica of *Xystonellopsis clevei* K. and C. Sta. 4699 (300–0 fms.). x 720.

Fig. 7. Knob and lance of the same lorica, showing the vane-like wings below the knob. x 720.

Fig. 8. Optical section of the wall at the oral end of the same lorica. Sta. 4701 (300–0 fms.). x 336.

Fig. 9. Detail of the surface of the oral end of *Xystonellopsis laticincta* K. and C. Sta. 4707 (300–0 fms.). x 720.

Fig. 10. Optical section of the wall at the oral end of *Xystonellopsis turgida* sp. nov. Sta. 4699 (300–0 fms.). x 720.

Fig. 11. Optical section of the knob and lance of lorica of *Xystonellopsis clevei* K. and C. Sta. 4701 (300–0 fms.). x 720.

Fig. 12. Lorica of *Xystonellopsis clevei* K. and C. Sta. 4701 (300–0 fms.). x 336.

Fig. 13. Lorica of *Xystonellopsis crassispinosa* K. and C. Sta. 4711 (300–0 fms.). x 336.

Fig. 14. Lorica of *Xystonellopsis clevei* K. and C. Sta. 4697 (300–0 fms.). x 336.

Fig. 15. Knob and lance of another lorica of the same. Sta. 4701 (300–0 fms.). x 720.

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PLATE 21

PLATE 21

Parundella and Xystonellopsis

Fig. 1. Lorica of *Xystonellopsis heroica* K. and C. Sta. 4671 (300–0 fms.). x 336.

Fig. 2. Optical section of the pedicel of another lorica of the same. Sta. 4617 (300–0 fms.). x 336.

Fig. 3. Optical section of the pedicel of *Xystonellopsis constricta* K. and C. Sta. 4701 (300–0 fms.). x 720.

Fig. 4. Optical section of the wall of the same lorica. x 720.

Fig. 5. Optical section of the wall of the oral region of *Xystonellopsis parva* sp. nov. Sta. 4701 (300–0 fms.). x 720.

Fig. 6. Lorica of *Xystonellopsis constricta* K. and C. Sta. 4699 (300–0 fms.). x 336.

Fig. 7. Optical section of the wall of the oral region of *Xystonellopsis constricta* K. and C. Sta. 4699 (300–0 fms.). x 720.

Fig. 8. Lorica of *Xystonellopsis parva* sp. nov. Sta. 4701 (300–0 fms.). x 336.

Fig. 9. Another lorica of the same. Sta. 4701 (300–0 fms.). x 336.

Fig. 10. Optical section of the wall of the oral region of *Xystonellopsis constricta* K. and C. Sta. 4571 (300–0 fms). x 720.

Fig. 11. Lorica of *Xystonellopsis brandti* (Laack.) Jörg. Sta. 4675 (300–0 fms.). x 336. Drawn by F. Abernathy.

Fig. 12. Lorica of *Xystonellopsis pinnata* K. and C. Sta. 4717 (300–0 fms.). x 336.

Fig. 13. Lorica of *Xystonellopsis acuminata* K. and C. Sta. 4583 (300–0 fms.). x 336.

Fig. 14. Lorica of *Parundella caudata* (Ost.) K. and C. Sta. 4571 (300–0 fms.). x 336.

Fig. 15. Lorica of *Xystonellopsis constricta* K. and C. Sta. 4699 (300–0 fms.). x 336.

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PLATE 22

PLATE 22

Xystonellopsis

Fig. 1. Optical section of the suboral band of *Xystonellopsis torta* (Kofoid) K. and C. Sta. 4676 (300–0 fms.). x 720.

Fig. 2. Optical section of the wall of the oral end of *Xystonellopsis hastata* (Bied.) K. and C. Sta. 4713 (300–0 fms.). x 336.

Fig. 3. Optical section of the knob and lance of *Xystonellopsis abbreviata* K. and C. Sta. 4571 (300–0 fms.). x 720.

Fig. 4. Surface view of the knob and lance of same lorica. x 720.

Fig. 5. Surface view of the knob and lance of the lorica of *Xystonellopsis laticincta* K. and C. Sta. 4707 (300–0 fms.). x 720.

Fig. 6. Optical section of the suboral band of the same lorica as fig. 13. x 720.

Fig. 7. Surface view of the knob and lance of *Xystonellopsis hastata* (Bied.) K. and C. Sta. 4713 (300–0 fms.). x 336.

Fig. 8. Optical section of the knob and lance of the same lorica. x 336.

Fig. 9. Optical section of the wall of the suboral band of *Xystonellopsis abbreviata* K. and C. Sta. 4571 (300–0 fms.). x 720.

Fig. 10. Optical section of the knob and lance of *Xystonellopsis pulchra* (Kofoid) K. and C. Sta. 4713 (300–0 fms.). x 720.

Fig. 11. Surface view of knob and lance of *Xystonellopsis torta* (Kofoid) K. and C. Sta. 4571 (300–0 fms.). x 720.

Fig. 12. Lorica of *Xystonellopsis laticincta* K. and C. Sta. 4707 (300–0 fms.). x 336.

Fig. 13. Aboral end of *Xystonellopsis favata* (Bdt.) K. and C. Sta. 4679 (300–0 fms.). x 720.

Fig. 14. Knob and lance of *Xystonellopsis pulchra* (Kofoid) K. and C. Sta. 4713 (300–0 fms.). x 720.

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PLATE 23

PLATE 23

Proplectella

Fig. 1. Lorica of *Proplectella urna* K. and C. Sta. 4701 (300–0 fms.). x 336.

Fig. 2. Lorica of *Proplectella prælonga* K. and C. Sta. 4661 (300–0 fms.). x 336.

Fig. 3. Lorica of *Proplectella ostenfeldi* K. and C. Sta. 4689 (300–0 fms.). x 673.

Fig. 4. Lorica of *Proplectella tenuis* K. and C. Sta. 4721 (300–0 fms.). x 336.

Fig. 5. Lorica of *Proplectella subangulata* K. and C. Sta. 4574 (300–0 fms.). x 336.

Fig. 6. Lorica of *Proplectella ellipsoida* K. and C. Sta. 4679 (300–0 fms.). x 336.

Fig. 7. Lorica of *Proplectella biangulata* K. and C. Sta. 4679 (300–0 fms.). x 336.

Fig. 8. Lorica of *Proplectella fastigata* (Jörg.) K. and C. Sta. 4580 (300–0 fms.). x 336.

Fig. 9. Lorica of *Proplectella ovata* (Jörg.) K. and C. Sta. 4717 (300–0 fms.). x 336.

Fig. 10. Lorica of *Proplectella pentagona* (Jörg.) K. and C. Sta. 4713 (300–0 fms.). x 336.

Fig. 11. Another lorica of the same. Sta. 4712 (surface). x 336.

Fig. 12. Lorica of *Proplectella prælonga* K. and C. Sta. 4650 (300–0 fms.). x 336.

Fig. 13. Lorica of *Proplectella amphora* K. and C. Sta. 4679 (300–0 fms.). x 336.

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PLATE 24

PLATE 24

Proplectella, Undella, and Undellopsis

Fig. 1. Lorica of *Proplectella perpusilla* K. and C. Sta. 4724 (300–0 fms.). x 336.

Fig. 2. Another lorica of the same. Sta. 4713 (300–0 fms.). x 336.

Fig. 3. Lorica of *Proplectella parva* K. and C. Sta. 4667 (300–0 fms.). x 336.

Fig. 4. Lorica of *Proplectella tumida* K. and C. Sta. 4706 (surface). x 336.

Fig. 5. Lorica of *Undella minuta* sp. nov. After Jörgensen (1924, p. 39, fig. 46, discussion on p. 43). x 223.

Fig. 6. Lorica of *Proplectella ellipsoida* K. and C. Sta. 4699 (300–0 fms.). x 336. Drawn by F. Abernathy.

Fig. 7. Lorica of *Undella media* sp. nov. Sta. 4583 (300–0 fms.). x 223.

Fig. 8. Lorica of *Undella ostenfeldi* K. and C. Sta. 4701 (800–0 fms.). x 336.

Fig. 9. Lorica of *Undella media* sp. nov. Sta. 4701 (300–0 fms.). x 223.

Fig. 10. Lorica of *Proplectella cuspidata* K. and C. Sta. 4713 (300–0 fms.). x 336.

Fig. 11. Lorica of *Undella mammilata* sp. nov. Sta. 4679 (300–0 fms.). x 223.

Fig. 12. Lorica of *Proplectella parva* K. and C., with coccoliths of Calyptrosphæra (?) on the surface. Sta. 4580 (surface). x 720.

Fig. 13. Lorica of *Undella mammilata* sp. nov. Sta. 4574 (300–0 fms.). x 223.

Fig. 14. Lorica of *Undella hyalinella* K. and C. Sta. 4571 (300–0 fms.). x 336.

Fig. 15. Lorica of *Undella californiensis* K. and C. Sta. 4847 (300–0 fms.). x 336.

Fig. 16. Lorica of *Undella turgida* K. and C. Sta. 4705 (300–0 fms.). x 336.

Fig. 17. Lorica of *Undella hemispherica* Laack. Sta. 4705 (300–0 fms.). x 336.

Fig. 18. Lorica of *Undellopsis entzi* K. and C. Sta. 4679 (300–0 fms.). x 336.

Fig. 19. Lorica of *Undella peruana* K. and C. Sta. 4679 (300–0 fms.). x 223.

Fig. 20. Lorica of *Undella pistillum* K. and C. Sta. 4666 (surface). x 336.

Fig. 21. Lorica of *Undella bulla* K. and C. Sta. 4580 (300–0 fms.). x 223.

Fig. 22. Lorica of *Undellopsis pacifica* K. and C. Sta. 4681 (800–0 fms.). x 336.

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PLATE 25

PLATE 25

Amplectella, Amplectellopsis, Undellopsis, and Cricundella

Fig. 1. Lorica of *Undellopsis insignata* K. and C. Sta. 4583 (300–0 fms.) x 336.

Fig. 2. Lorica of *Amplectellopsis biedermanni* K. and C. Sta. 4701 (300–0 fms.). x 336.

Fig. 3. Lorica of *Amplectella bulbosa* sp. nov. Sta. 4701 (300–0 fms.). x 336.

Fig. 4. Lorica of *Amplectella occidentalis* K. and C. Sta. 4724 (300–0 fms.). x 336.

Fig. 5. Lorica of *Undellopsis anularius* K. and C. Sta. 4699 (300–0 fms.). x 336.

Fig. 6. Lorica of *Cricundella quadricincta* K. and C. Sta. 4701 (800–0 fms.). x 336.

Fig. 7. Lorica of *Undellopsis angulata* sp. nov. Sta. 4681 (800–0 fms.). x 336.

Fig. 8. Lorica of *Cricundella quadridivisa* K. and C. Sta. 4699 (300–0 fms.). x 336.

Fig. 9. Lorica of *Amplectellopsis angularis* K. and C. Sta. 4701 (300–0 fms.). x 336.

Fig. 10. Lorica of *Undellopsis truncata* sp. nov. Sta. 4687 (300–0 fms.). x 336.

Fig. 11. Lorica of *Undellopsis umbilicata* K. and C. Sta. 4695 (300–0 fms.) x 336.

Fig. 12. Lorica of *Amplectella præacuta* K. and C. Sta. 4695 (300–0 fms.). x 336.

Fig. 13. Lorica of *Amplectella quadricollaria* K. and C. Sta. 4705 (2031–0 fms.). x 336.

Fig. 14. Lorica of *Undellopsis cubitum* K. and C. Sta. 4713 (300–0 fms.). x 336.

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PLATE 26

PLATE 26

Dictyocysta

Fig. 1. Lorica of *Dictyocysta mexicana* K. and C. Sta. 4583 (300–0 fms.). x 336.

Fig. 2. Lorica of *Dictyocysta occidentalis* K. and C. Sta. 4701 (300–0 fms.). x 720.

Fig. 3. Lorica of *Dictyocysta reticulata* K. and C. Sta. 4665 (300–0 fms.). x 336.

Fig. 4. Lorica of *Dictyocysta mexicana* K. and C., showing the closing-apparatus. Sta. 4663 (surface). x 336.

Fig. 5. Oral view of lorica of *Dictyocysta reticulata* K. and C., showing the closing-apparatus. Sta. 4665 (300–0 fms.). x 336.

Fig. 6. Lorica of *Dictyocysta duplex* Brandt. Sta. 4671 (surface). x 336.

Fig. 7. Another lorica of the same. Sta. 4675 (300–0 fms.). x 720.

Fig. 8. Lorica of *Dictyocysta polygonata* K. and C., with coccoliths of *Coccosphæra pelagica* on the bowl. Sta. 4615 (surface). x 336.

Fig. 9. Lorica of *Dictyocysta tiara* Hckl. Sta. 4675 (300–0 fms.). x 336.

Fig. 10. Lorica of *Dictyocysta fenestrata* K. and C. Sta. 4675 (300–0 fms.). x 336.

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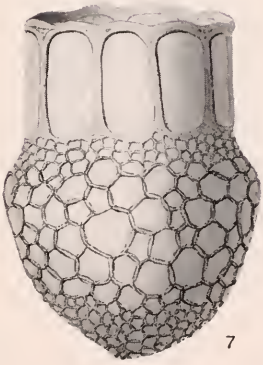
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PLATE 27

PLATE 27

Dictyocysta

Fig. 1. Lorica of *Dictyocysta californiensis* K. and C. Sta. 4583 (300–0 fms.). x 720.

Fig. 2. Lorica of *Dictyocysta mülleri* (Imhof) Jörg., with the closing-apparatus. Sta. 4571 (300–0 fms.). x 336.

Fig. 3. Lorica of *Dictyocysta pacifica* K. and C. Sta. 4713 (300–0 fms.). x 720.

Fig. 4. Another lorica of the same. Sta. 4681 (300–0 fms.). x 720.

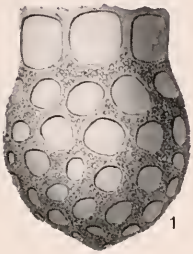
Fig. 5. Lorica of *Dictyocysta ampla* K. and C. Sta. 4580 (300–0 fms.). x 336.

Fig. 6. Lorica of *Dictyocysta spinosa* K. and C. Sta. 4681 (300–0 fms.). x 720.

Fig. 7. Lorica of *Dictyocysta pacifica* K. and C., with coccoliths of *Umbilicosphæra mirabilis* on the lower part of the bowl. Sta. 4666 (800–0 fms.). x 720.

Fig. 8. View of aboral end of lorica of *Dictyocysta mitra* Hæckel. Sta. 4701 (300–0 fms.). x 336.

Fig. 9. Lorica of *Dictyocysta minor* Jörg. Sta. 4574 (300–0 fms.). x 720.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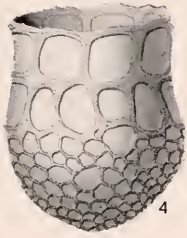
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PLATE 28

PLATE 28

Canthariella, Steenstrupiella, Amphorella, Amphorellopsis, Odontophorella, and Daturella

Fig. 1. Lorica of *Daturella recta* K. and C. Sta. 4717 (300–0 fms.). x 336.

Fig. 2. Lorica of *Steenstrupiella gracilis* K. and C. Sta. 4684 (surface). x 336.

Fig. 3. Lorica of *Amphorellopsis lævis* K. and C. Sta. 4637 (300–0 fms.). x 336.

Fig. 4. Cross section near the aboral end of the same lorica. x 336.

Fig. 5. Lorica of *Steenstrupiella steenstrupii* (Claparède and Lachmann) K. and C. Sta. 4576 (surface). x 336.

Fig. 6. Lorica of *Amphorellopsis turbinea* K. and C. Sta. 4724 (300–0 fms.). x 336.

Fig. 7. Detail of the oral end of *Odontophorella serrulata* K. and C. Sta. 4721 (300–0 fms.). x 720.

Fig. 8. Lorica of *Amphorellopsis acantharus* K. and C. Sta. 4655 (300–0 fms.). x 336.

Fig. 9. Lorica of *Amphorellopsis tropica* K. and C. Sta. 4740 (300–0 fms.). x 336.

Fig. 10. Detail of a fin of *Odontophorella serrulata* K. and C. Sta. 4721 (300–0 fms.). x 720.

Fig. 11. Lorica of *Canthariella truncata* K. and C. Sta. 4709 (300–0 fms.). x 336.

Fig. 12. Lorica of *Canthariella brevis* K. and C. Sta. 4722 (300–0 fms.). x 336.

Fig. 13. Lorica of *Daturella stramonium* K. and C. Sta. 4587 (300–0 fms.). x 336. Drawn by F. Abernathy.

Fig. 14. Lorica of *Steenstrupiella robusta* K. and C. Sta. 4711 (300–0 fms.). x 336. Drawn by F. Abernathy.

Fig. 15. Lorica of *Amphorellopsis quadrangula* K. and C. Sta. 4621 (300–0 fms.). x 336. Drawn by F. Abernathy.

Fig. 16. Lorica of *Canthariella septinaria* K. and C. Sta. 4717 (300–0 fms.). x 336.

Fig. 17. Lorica of *Amphorella quadrilineata* (Clap. and Lach.) Dad. Sta. 4543 (surface). x 336.

Fig. 18. Another view of the same lorica. x 336.

Fig. 19. Lorica of *Odontophorella serrulata* K. and C. Sta. 4721 (300–0 fms.). x 336.

Fig. 20. Lorica of *Amphorella amphora* (Clap. and Lach.) Dad. Sta. 4731 (surface). x 336.

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PLATE 29

PLATE 29

Albatrossiella, Dadayiella, Prostelidiellä, and Stelidiella

Fig. 1. Lorica of *Dadayiella ganymedes* (Entz, Sr.) K. and C., tilted to show the outlines of the oral opening. Sta. 4709 (300–0 fms.). x 336.

Fig. 2. Lorica of *Dadayiella bulbosa* (Bdt.) K. and C. Sta. 4650 (300–0 fms.). x 336.

Fig. 3. Lorica of *Dadayiella curta* K. and C. Sta. 4613 (300–0 fms.). x 336.

Fig. 4. Lorica of *Dadayiella acutiformis* nom. sp. nov. Sta. 4666 (surface). x 336.

Fig. 5. Lorica of *Dadayiella cuspis* K. and C. Sta. 4709 (300–0 fms.). x 720.

Fig. 6. Lorica of *Dadayiella curta* K. and C. Sta. 4571 (300–0 fms.). x 336.

Fig. 7. Aboral region and lower bowl of *Dadayiella ganymedes* (Entz, Sr.) K. and C. Sta. 4709 (300–0 fms.). x 336.

Fig. 8. Lorica of *Stelidiella fenestrata* K. and C. Sta. 4637 (300–0 fms.). x 336.

Fig. 9. Optical section of the aboral region and lower bowl of *Dadayiella ganymedes* (Entz, Sr.) K. and C. Sta. 4709 (300–0 fms.). x 336.

Fig. 10. Lorica of *Prostelidiella phialia* K. and C. Sta. 4662 (800–0 fms.). x 336. Drawn by F. Abernathy.

Fig. 11. Lorica of *Albatrossiella agassizi* K. and C. Sta. 4742 (300–0 fms.). x 336.

Fig. 12. Detail of the aboral end of *Stelidiella fenestrata* K. and C. Sta. 4717 (300–0 fms.). x 336.

Fig. 13. Lorica of *Dadayiella ganymedes* (Entz, Sr.) K. and C. Sta. 4640 (300–0 fms.). x 336.

Fig. 14. Lorica of *Stelidiella simplex* K. and C. Sta. 4740 (300–0 fms.). x 336.

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PLATE 30

PLATE 30

Daturella and Ormosella

Fig. 1. Lorica of *Daturella striata* K. and C. Sta. 4571 (300–0 fms.). x 223.

Fig. 2. Lorica of *Daturella ora* K. and C. Sta. 4724 (300–0 fms.). x 223.

Fig. 3. Lorica of *Daturella magna* K. and C. Sta. 4571 (300–0 fms.). x 223.

Fig. 4. Lorica of *Ormosella schweyeri* K. and C. Sta. 4722 (300–0 fms.). x 336.

Fig. 5. Lorica of *Ormosella hæckeli* K. and C. Sta. 4662 (800–0 fms.). x 336.

Fig. 6. Lorica of *Ormosella bresslaui* K. and C. Sta. 4722 (300–0 fms.). x 336.

Fig. 7. Lorica of *Ormosella schweyeri* K. and C. Sta. 4711 (300–0 fms.). x 336.

Fig. 8. Lorica of *Ormosella bresslaui* K. and C. Sta. 4724 (300–0 fms.). x 336.

Fig. 9. Aboral end of lorica of *Ormosella schmidti* K. and C. Sta. 4724 (300–0 fms.). x 720.

Fig. 10. Lorica of *Ormosella apsteini* K. and C. Sta. 4634 (300–0 fms.). x 336.

Fig. 11. Lorica of *Ormosella schmidti* K. and C. Sta. 4701 (300–0 fms.). x 336.

Fig. 12. Another lorica of the same. Sta. 4679 (300–0 fms.). x 336.

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PLATE **31**

PLATE 31

Eutintinnus

Fig. 1. Lorica of *Eutintinnus perminutus* K. and C. Sta. 4719 (300–0 fms.). x 336.

Fig. 2. Lorica of *Eutintinnus pacificus* K. and C. Sta. 4722 (surface). x 336.

Fig. 3. Another lorica of the same. Sta. 4722 (300–0 fms.). x 336.

Fig. 4. Lorica of *Eutintinnus apertus* K. and C. Sta. 4634 (300–0 fms.). x 336.

Fig. 5. Lorica of *Eutintinnus procurrerens* K. and C. Sta. 4690 (surface). x 336.

Fig. 6. Lorica of *Eutintinnus pinguis* K. and C. Sta. 4583 (surface). x 336.

Fig. 7. Lorica of *Eutintinnus elongatus* (Jörg.). Sta. 4706 (surface). x 336.

Fig. 8. Lorica of *Eutintinnus medius* K. and C. Sta. 4576 (300–0 fms.). x 336.

Fig. 9. Lorica of *Eutintinnus birictus* K. and C. Sta. 4574 (300–0 fms.). x 336. Drawn by F. Abernathy.

Fig. 10. Lorica of *Eutintinnus fraknóii* (Dad.). Sta. 4666 (300–0 fms.). x 336. Drawn by V. G. Sorrel.

Fig. 11. Lorica of *Eutintinnus colligatus* K. and C. Sta. 4705 (300–0 fms.). x 336.

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PLATE **32**

PLATE 32

Eutintinnus

Fig. 1. Lorica of *Eutintinnus macilentus* (Jörg.). Sta. 4724 (300–0 fms.). x 336.

Fig. 2. Lorica of *Eutintinnus tenuis* (K. and C.). Sta. 4580 (surface). x 336.

Fig. 3. Lorica of *Eutintinnus lusus-undæ* (Entz, Sr.). Sta. 4705 (300–0 fms.). x 336.

Fig. 4. Lorica of *Eutintinnus turgescens* (K. and C.). Sta. 4713 (300–0 fms.). x 336.

Fig. 5. Lorica of *Eutintinnus rugosus* (K. and C.). Sta. 4675 (300–0 fms.). x 336.

Fig. 6. Lorica of *Eutintinnus stramentus* (K. and C.). Sta. 4583 (surface). x 336.

Fig. 7. Lorica of *Eutintinnus tubiformis* (K. and C.). Sta. 4722 (surface). x 336.

Fig. 8. Lorica of *Eutintinnus tubulosus* (Ost.). Sta. 4676 (800–0 fms.). x 336.

Fig. 9. Lorica of *Eutintinnus brandti* (K. and C.). Sta. 4734 (300–0 fms.). x 336.

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PLATE 33

PLATE 33

Salpingella

Fig. 1. Lorica of *Salpingella laminata* sp. nov. Sta. 4709 (300–0 fms.). x 720.

Fig. 2. Lorica of *Salpingella secata* (Brandt). Sta. 4697 (300–0 fms.). x 223.

Fig. 3. Another lorica of the same. Sta. 4709 (300–0 fms.). x 223.

Fig. 4. Lorica of *Salpingella minutissima* K. and C. Sta. 4571 (300–0 fms.). x 223.

Fig. 5. Lorica of *Salpingella attenuata* (Jörgensen). Sta. 4590 (300–0 fms.). x 223.

Fig. 6. Another lorica of the same. Sta. 4571 (300–0 fms.). x 223.

Fig. 7. Lorica of *Salpingella acuminata* (Clap. and Lach.) Jörg. Sta. 4717 (300–0 fms.). x 336. Drawn by A. L. Hamilton.

Fig. 8. Lorica of *Salpingella incurva* sp. nov. Sta. 4717 (300–0 fms.). x 336.

Fig. 9. Lorica of *Salpingella gracilis* K. and C. Sta. 4701 (300–0 fms.). x 336.

Fig. 10. Lorica of *Salpingella ricta* K. and C. Sta. 4638 (300–0 fms.). x 223.

Fig. 11. Lorica of *Salpingella tuba* sp. nov. Sta. 4679 (300–0 fms.). x 223. Drawn by F. Abernathy.

Fig. 12. Another lorica of the same. Sta. 4707 (300–0 fms.). x 336.

Fig. 13. Detail of the oral end of lorica of *Salpingella tuba* sp. nov. Sta. 4707 (300–0 fms.). x 336.

Fig. 14. Lorica of *Salpingella sinistra* sp. nov. Sta. 4703 (300–0 fms.). x 336.

Fig. 15. Lorica of *Salpingella glockentögeri* (Brandt) Jörg. Sta. 4638 (300–0 fms.). x 223.

Fig. 16. Another lorica of the same. Sta. 4659 (300–0 fms.). x 223.

Fig. 17. Lorica of *Salpingella jugosa* K. and C. Sta. 4724 (800–0 fms.). x 336.

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PLATE **34**

PLATE 34

Salpingella and Salpingacantha

Fig. 1. Lorica of *Salpingella faurei* K. and C. Sta. 4571 (300–0 fms.). x 336.

Fig. 2. Detail of the oral end of *Salpingacantha unguiculata* (Bdt.) K. and C. Sta. 4724 (300–0 fms.). x 720.

Fig. 3. Detail of the oral end of *Salpingacantha undata* (Jörg.) K. and C. (300–0 fms.). x 336.

Fig. 4. Lorica of *Salpingacantha crenulata* K. and C. Sta. 4713 (300–0 fms.). x 336.

Fig. 5. Lorica of *Salpingella rotundata* K. and C. Sta. 4717 (300–0 fms.). x 336.

Fig. 6. Lorica of *Salpingacantha unguiculata* (Bdt.) K. and C. Sta. 4724 (300–0 fms.). x 336.

Fig. 7. Lorica of *Salpingella curta* K. and C. Sta. 4734 (300–0 fms.). x 336.

Fig. 8. Lorica of *Salpingacantha undata* (Jörg.) K. and C. Sta. 4681 (300–0 fms.). x 336.

Fig. 9. Lorica of *Salpingella curta* K. and C. Sta. 4724 (300–0 fms.). x 336.

Fig. 10. Lorica of *Salpingella expansa* K. and C. Sta. 4699 (300–0 fms.). x 223.

Fig. 11. Lorica of *Salpingacantha exilis* K. and C. Sta. 4648 (300–0 fms.). x 336.

Fig. 12. Lorica of *Salpingacantha perca* K. and C. Sta. 4709 (300–0 fms.). x 720.

Fig. 13. Lorica of *Salpingacantha ampla* K. and C. Sta. 4709 (300–0 fms.). x 336.

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PLATE 35

PLATE 35

Salpingella, Rhabdosella, and Epicranella

Fig. 1. Lorica of *Rhabdosella cuneolata* (K. and C.). Sta. 4617 (300–0 fms.). x 336.

Fig. 2. Lorica of *Epicranella bella* K. and C. Sta. 4675 (300–0 fms.). x 223. Drawn by F. Abernathy.

Fig. 3. Lorica of *Epicranella bellissima* sp. nov. Sta. 4705 (2031–0 fms.). x 223. Drawn by F. Abernathy.

Fig. 4. Lorica of *Epicranella dextra* sp. nov. Sta. 4721 (300–0 fms.). x 223. Drawn by F. Abernathy.

Fig. 5. Lorica of *Salpingella subconica* K. and C. Sta. 4713 (300–0 fms.). x 336.

Fig. 6. Lorica of *Rhabdosella octogenata* (K. and C.). Sta. 4730 (300–0 fms.). x 336.

Fig. 7. Lorica of *Epicranella magnifica* sp. nov. Sta. 4673 (300–0 fms.). x 336.

Fig. 8. Detail of the surface structure of the wall of the same lorica. x 720.

Fig. 9. Lorica of *Epicranella prismatica* K. and C. Sta. 4709 (300–0 fms.). x 720.

Fig. 10. Detail of the surface structure of the wall of the same lorica. x 720.

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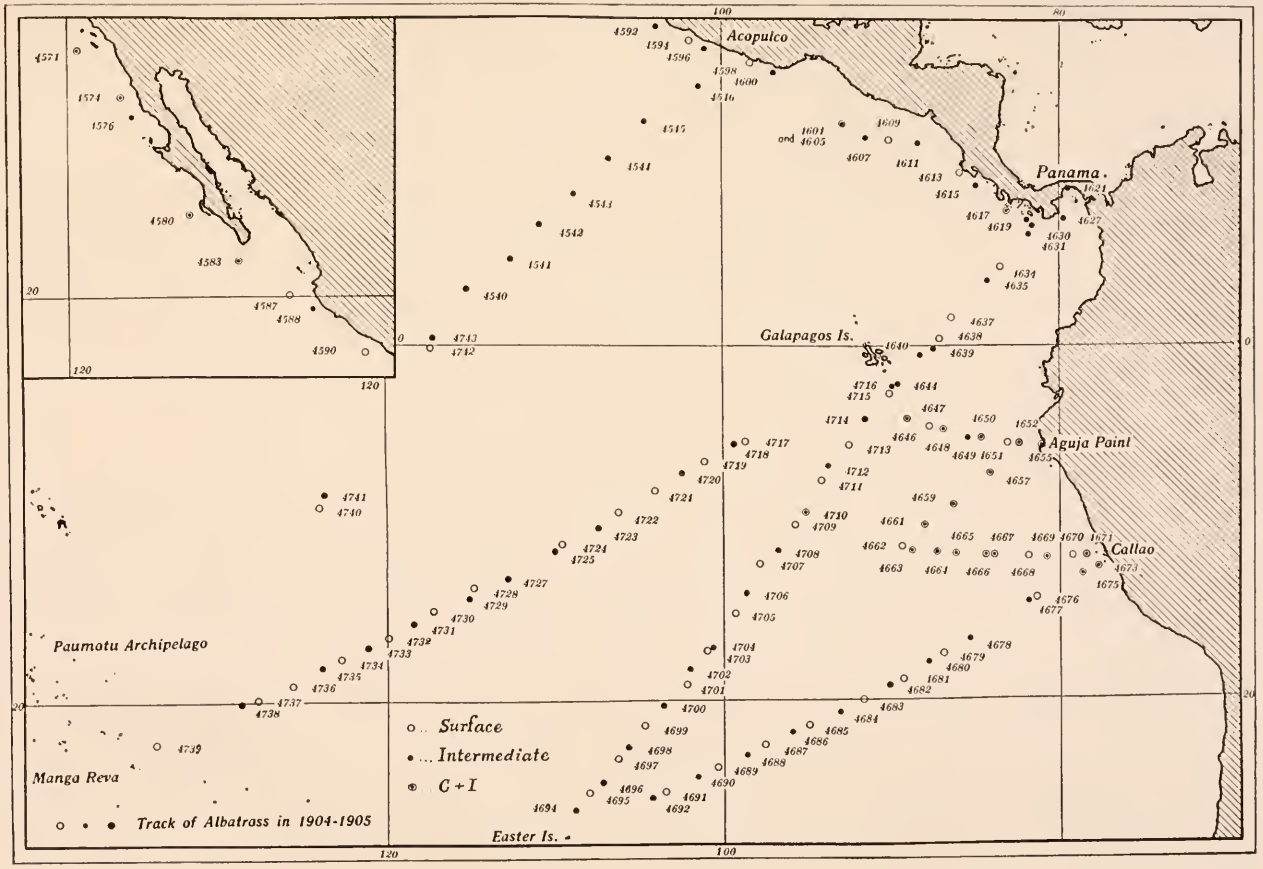
PLATE 36

PLATE 36

Showing position of the stations occupied by the "Albatross" during her cruise in the Eastern Pacific in 1904–1905.


Acopulco
Panama
Galapagos Is.
Aguja Point
Callao
Paumotu Archipelago
Manga Reva
Easter Is.
Surface
Intermediate
C + I
Track of Albatross in 1904-1905

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